(PUBLISHED QUARTERLY)

# Journal of the Council for Scientific and Industrial Research.

Vol. 2. AUGUST, 1929. No. 3.

## The Building Research Laboratory in Great Britain.

*By A. S. Fitzpatrick, M.Sc.**

"I tell this tale which is strictly true
Just by way of convincing you
How very little since things were made
Things have altered in the building trade."
(KIPLING.)

In 1920, the British Government, acting through the Department of Scientific and Industrial Research, established the Building Research Station in temporary quarters at Acton, London. The Station was later moved to its present position near Watford, 20 miles from London.

As with most research subjects of any magnitude, building research in England has taken some years to reach that stage where the value of the results are apparent to the industry. But if one may gauge the success of a research station by the interest and financial support given to it by the industry, the Building Research Station ranks as one of the most successful of those set up by the British Government. The British Institute of Builders and similar builders' organizations have recently shown their appreciation by making monetary grants to extend the researches of the station which are carried out under the direction of Dr. R. E. Stradling.

In the building trade, where the interests of the architect, engineer, chemist, mason, plumber, bricklayer, plasterer, carpenter, and even the man in the street meet on common ground, there is an amazing number of unsolved problems. It is as though this common field has remained a no-man's land, and the information available is therefore mostly of a rule of thumb or empirical nature. Although the industry is as old as the human race itself, problems are still causing losses which daily cost the community hundreds, perhaps even thousands, of pounds sterling.

At the root of most of these problems, there are a small number of fundamental questions, the study of which has been recognized as the essential task of the Building Research Station. These questions include such matters as weathering, the physical and chemical nature of building materials, and the acoustic and thermal efficiency of buildings. If these fundamental questions are fully answered, the knowledge so gained will solve many of the difficulties arising from day to day in building construction. These fundamental questions are

* Mr. Fitzpatrick is a part-time officer of this Council and of the Development and Migration Commission. He is located at Australia House, London.

being tackled in that part of the Station's programme known as General Research. Clearly the investigations in this section are of a protracted nature, and, if the Station meanwhile is to secure adequate financial support from the industry, the staff must be in a position to advise builders and architects on their more immediate difficulties. The second part of the Station's programme is, therefore, an Intelligence and Special Investigations Section.

Although the intelligence service helps to secure the financial co-operation of builders and architects during the progress of general researches, it fulfils another useful purpose. Not only do the many inquiries received by this section keep the staff of the Station in touch with the industry but, in some cases, they reveal gaps in fundamental knowledge. Again, the details given when an inquiry is made sometimes give a clue to the solution of a general research problem. By these co-operative methods of investigation, the advances have been so striking that the Institute of Builders has lately made a special grant to enable the work of the Station to become more widely known throughout the industry.

The most important of the general researches at the Station is that concerned with weathering. The problem has been tackled along biological, chemical and physical lines as well as by the study of faulty treatment of materials. The effect of individual agents causing decay cannot usually be isolated. Bacteria do not appear to exert a strong action on building stones but the chemical influence of sulphuric acid arising from the combustion of coal in domestic fires and industrial furnaces is of first-rate importance. This leads to the formation of a hard impervious surface skin, mainly of calcium sulphate, which causes the blistering and flaking of limestone—a source of deterioration more serious even than that of erosion. Physical agencies, such as the dissolution and recrystallization of inorganic salts, also have a marked effect. Particularly is this the case where sandstones and limestones have been used in juxtaposition. Excessive decay of the sandstones then occurs by the absorption of soluble sulphates from the limestone. These soluble sulphates crystallize within the sandstone and so disrupt the material.

Since the nature of this associative decay had not been recognized until quite recently, the proposal was made that sandstone should be used to repair the limestone structure of the Houses of Parliament. That proposal has now been abandoned.

In conjunction with studies on weathering, the staff of the Building Research Station has devised useful standard tests for the determination of heat and moisture movements in bricks, building stones, and timber, &c. An interesting example is the test devised for the durability of bituminous roofing felts under exposure to the atmosphere. By means of a mercury vapour lamp, water spray, and heating and cooling mechanism, a weathering cycle reproducing the effects of rain, mists, frost, heat, and sunlight has been evolved for the laboratory study of these materials. The laboratory results show a close similarity of those obtained by months, or even years, of exposure to weather changes.

Studies on limes and plasters, cement, concrete, terra cotta, wall boards, roofing tiles, flooring materials, and artificial stones, have led,

not only to improved methods of making or treating these materials, but also to that clearer definition of qualities which is essential to the work of the British Engineering Standards Association.

Failures in concrete structures have led to work on the composition of concretes. In the case of breeze or clinker concrete, it has been shown that failures have been due to the presence of unburnt coal which may absorb water and oxygen and by expansion lead to cracking of the concrete aggregate.

The item of building research of most popular interest in England is that referring to the standardization of room conditions in an experimental house. This involves a comparison of methods of heating and of the heat requirements of different rooms in order to keep a room comfortable for sedentary occupation. This "comfortable" condition is said to be reached when "a sizable black body of 75° F. loses heat at the rate of 17.5 B. Th.U. per square foot per hour" and a thermostatic device has been worked out to maintain the condition. This very sensitive automaton is responsive to surrounding objects, to draughts and sunshine. By its use, the staff of the Station has been able to determine conditions for the best ventilation, warming of walls, and other thermal and structural features in an ideal house.

The foregoing are a few examples from a programme of work which is giving valuable aid to British builders and architects in their immediate scientific difficulties. By more fundamental studies into the nature and behaviour of building materials, the Building Research Station is laying a sound foundation for improved technique in the building industry. This work is primarily important for the restoration, maintenance, and construction of English buildings.

In Australia also where the erection of buildings for her growing population is of particular importance, the aesthetic and economic aspects of building merit keen interest in the community.

# Dried Fruit Grubs—The Ethylene Dichloride–Carbon Tetrachloride Fumigation Process.

*By J. E. Thomas, B.Sc., B.V.Sc., B.Agr.Sc., Commonwealth Research Station, Merbein (Victoria).*



## 1. Introductory.

Fumigation, as a means of control of the dried fruit pests, has been practised for a considerable period; but, at the present time, it can hardly be claimed that any of the methods commercially adopted in Australia have been wholly successful. The role of fumigation in the ultimate control of the dried-fruit pests—in particular *Plodia interpunctella* and *Ephestia cautella*— is one of palliation only. Successful storage of dried fruit requires that the pests be destroyed at an early stage of infestation before damage to the fruit occurs. Under the present methods of handling and packing, re-infection may occur, and hence entail further fumigations.

Two main methods have been practised. Carbon disulphide was, at first, extensively employed. As experiments showed, however, that the percentage of larvae killed was not satisfactory, and, in addition, as there was the ever present danger of explosion, its use was, to a great extent, abandoned. When this gas was used in a vacuum of about 30 inches of mercury, it was found to be extremely efficient, but its application is considered to be commercially impracticable, owing to the high capital cost involved in relation to the capacity of the plant.

Hydrocyanic acid fumigation is now generally adopted. It is not considered satisfactory, as its toxicity renders it very dangerous in unskilled hands; and, further, experiments have demonstrated that the gas—probably owing to its low density—has so little penetrating power that larvae in the centre of the packed fruit often escape.

The requirements of the ideal fumigant for dried fruits are that it should be:—(*a*) non-inflammable; (*b*) not dangerous to the operators; (*c*) toxic to the three stages of the pest—egg, larva, and pupa—in the packed fruit. Lyon* states that, of the processes mentioned, only carbon disulphide, *in vacuo*, fulfils requirement (*c*) above. The factor of toxicity to the egg is not of much importance in the case of winter fumigation in Australia, or of fumigation of export fruit immediately on arrival in London. Lyon† has definitely shown that there are very few viable eggs present in the winter months in Australia, while from observations made by Hill.‡ there would be few present when the fruit arrives in London. In other seasons, in particular early spring in Australia, and during the English summer, destruction of the eggs is essential, as otherwise active larvae may appear in a very short period. At present, fumigation in London is the chief method of control. The obvious drawbacks are that it does not guard against damage prior to arrival or later infection in London storehouses.

* *Journal of Agriculture, South Australia*, **29** (1926), p. 956.
† "Entomological Pests of Dried Fruit." Unpublished report. C.S.I.R., 1927.
‡ This Journal, **1** (1928), p. 333.

## 2. The Ethylene Dichloride-Carbon Tetrachloride Fumigation System.

*General.*—Roark and Cotton of the United States Department of Agriculture, after an extensive search for new volatile compounds suitable for fumigation, have recommended the use of an ethylene dichloride-carbon tetrachloride mixture.* The use of trichlorethylene and carbon tetrachloride was mentioned by Knapp,† in fact, as early as 1921, but the scale of dosage suggested is, in the light of later experience, entirely inadequate.† Roark and Cotton finally chose ethylene dichloride three parts, and carbon tetrachloride one part, by volume. In their summary, they state that the mixture recommended is non-inflammable, it gives little discomfort to the operators, and, since the gas produced is three times heavier than air, a high penetrability is obtained by displacement. The mixture appeared to be five times as toxic as carbon tetrachloride which is added mainly to make the combination non-inflammable. Further, carbon tetrachloride boils at 76.8° C., and ethylene dichloride at 83.7° C., so that the mixture evaporates almost as a single compound. In their experiments, this mixture, when used at a dosage rate of 14 lb. per 1,000 c. ft. for 24 hours at temperatures above 65° F. was 100% lethal against the larvae of the furniture beetle (*Anthrenus vorax*) and the black carpet beetle (*Attagenus piceus*). Used against the larvae of the rice weevil (*Sitophilus oryza*), the flour beetle (*Tribolium sp.*) and the dried fruit moth (*Plodia interpunctella*) sealed up in cartons, a 100% kill was obtained with a similar dosage at temperatures above 80° F. Recently similar results have been obtained by Hoyt‡, who carried out tests with the larvae of the flour beetle (*Tribolium sp.*). The scale of dosage ranged between 14.0–16.5 lb. per 1,000 cub. ft. for 24 hours. The results were satisfactory, but the kill was not immediate, some larvae surviving for three days before death ensued.

The results from this method of fumigation appeared to be so satisfactory that it was thought desirable to carry out some extended trials at Merbein and, in co-operation with Mr. D. C. Winterbottom, General Manager of the Mildura Co-operative Fruit Company, who imported and supplied the necessary fumigant materials, the following tests were carried out.

## 3. Experimental Procedure.

(1) *Tests with the eggs of Plodia interpunctella.*—In the following tests, the general method employed was to remove female moths at about the stage of oviposition from the insectary to a glass jar. The eggs were laid on sterile sultanas and, when about 12–16 hours old, were used to infect the experimental sultana berries. The experimental samples in each test were then exposed to the fumigant mixture in a bell jar. The dosage rate was 14 lb. per 1,000 cub. ft., the required amount of the mixture being placed in a watch glass under the top of the jar and allowed to evaporate. After 22 hours' exposure the berries were removed and held aside in moth-proof containers for a period of not less than fifteen days. Previous experiments have shown that, at the temperature prevailing in the spring and summer months, very

* *Journal of Economic Entomology*, **20** (1927), p. 636.

† "Insect Pests in the Cocoa Store." Technical Publication of Bournville Works, England, 1921, p. 13.

‡ *Journal of Industrial and Engineering Chemistry*, **20** (1928), p. 460.

rarely were any eggs viable after a period of fourteen days. In all of the tests, control samples selected at random were held as checks. The results obtained are shown in Table I.

TABLE I.

*Tests with the eggs of Plodia interpunctella.*

| Test. | Date. | Age of Egg. | No. of Samples (unit—one berry). | | Eggs per Sample. | Percentage of Eggs which Developed. | | Temperature Record (during fumigation). Degrees Fah. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Hours. | F. | C. | | F. | C. | Max. | Min. | W.M. |
| (*a*) | 26.11.28 | 12–16 | 0·6 | 6 | 10 | 0·0 | 33 (R. 30–40) | 96 | 74 | 86 |
| (*b*) i | 26.1.29 | 24 | 0·6 | 6 | 10 | 0·16 | 30 (R. 20–40) | 77 | 58 | 66 |
| ii | 27.1.29 | 10 | 6 | 6 | 10 | 0·0 | 66 (R. 60–70) | 72 | 51 | 62 |
| (*c*) | 6.2.29 | 12–16 | 15 | 15 | 10 | 2·0 | 50 (R. 40–60) | 84 | 59 | 73 |
| | | ,, | 1 | 1 | 50 | | | | | |

F.—Fumigated sample. C.—Control, not fumigated. R.—Range.

*Bulk Test* (7/2/29).—In this test, moths were allowed to oviposit freely on two bulk samples of fruit, each weighing about one pound. These samples were heavily infested with the adults and larvae of the saw-toothed grain beetle (*Silvanus suraminensis*). No accurate counts of the eggs could be made, but it was estimated that approximately 200 were present in each box. One sample of fruit was then exposed to the fumigant for a period of 22 hours. Both samples were then held aside and examined later (27/2/29).

*Results.—Fumigated Sample*—No *Plodia* larvae present, one live adult *Silvanus* and ten larvae found.

*Control Sample*—Fruit heavily infested with the larvae of *Plodia* and the adults and larvae of *Silvanus*.

Temperature record during fumigation:—Maximum, 86° F.; minimum, 56° F.; weighted mean, 78° F.

(2) *Tests with the Larvae of Plodia interpunctella.*—(*a*) Fifty larvae at various stages of development were exposed to the action of the fumigant in a bell jar applied at a dosage of the rate of 14 lb. per 1,000 cub. ft. All were dead after one hour's exposure at a temperature of 77° F.

(*b*) In order to make the conditions of the test correspond as closely as possible to those prevailing in practice, a tin container 9 inches long and 3 inches in diameter, open at both ends, was used. Larvae packed in the centre of this could be considered as inaccessible as those in the centre of a 56-lb. box of packed fruit. Fifty larvae were packed in a small tin receptacle approximately 1¼ inches in diameter and 1 inch long, the ends of which were closed with wire gauze (60 to the inch). This receptacle was then tied round with linen and packed in the centre of the container. Sultanas were packed on both sides with considerable pressure.

TABLE II.

*Tests with the Larvae of Plodia interpunctella.*

| Date. | Rate of Dosage (lb. per 1,000 cubic feet). | Period of Exposure. | Percentage of Kill. | Temperature Records—Fah. | | |
|---|---|---|---|---|---|---|
| | | | | Max. | Min. | W.M. |
| 22.11.28 | 14·0 | 22 hours | 100% .. .. .. | 97 | 75 | 86 |
| 29.11.28 | 10·5 | „ | 80%, 100% by next day .. | 103 | 83 | 93 |
| 28.11.28 | 7·0 | „ | 50%, 100% within three days | 99 | 79 | 90 |
| 30.11.28 | 3·5 | „ | 6% killed in container, 15% when freely exposed | 101 | 79 | 90 |
| 7.2.29 | 14·0 | „ | 95% in container; 2% of larvae later pupated | 86 | 56 | 79 |

Controls were prepared in several cases, and in each instance 100% live larvae were recovered from the container.

(3) *Tests with the Pupae of Plodia interpunctella* (1/2/29).—Six test tubes, each containing eight pupae, were exposed to the mixture for 22 hours at a dosage rate of 14 lb. per 1,000 cub. ft. Six similar samples were held aside as checks.

*Results.—Percentage Emergence of Moths*—Fumigated, 0.0%.
Control, 25.0%.
(First moth emerged, 6/2/29.)

Temperature Records—

| | |
|---|---|
| Maximum .. .. .. | 71° F. |
| Minimum .. .. .. | 50° F. |
| Weighted mean .. .. | 61° F. |

## 4. Discussion of Small Scale Experimental Results.

The foregoing laboratory results indicate clearly that, when the mixture is used at the rate of 14 lb. per 1,000 cub. ft. at temperatures above 70° F. it has a very high toxicity towards the three stages of the principal dried fruit pest—*Plodia interpunctella.* The tests, in the case of the eggs, extended over a period of 73 days, thus making provision for any possible variation in viability of various batches. This mixture does not appear to be toxic towards the egg of *Silvanus*—a secondary pest of minor importance. The gas is one of the few which are markedly toxic to the *Plodia* egg. In reporting some tests on the Plumridge system of fumigation, Myers* states that, with the *Plodia* egg, a 98% kill was obtained. This particular system, which employs a gas of secret composition, is at present used to treat all Australian dried fruit on arrival at London.

The mixture appears to penetrate well and, in the experiments recorded above, a high lethal effect was obtained with buried larvae, even down to a dosage of 7 lb. per 1,000 cub. ft. The question of penetrability is of most importance in the case of the larvae which may be found in the centre of the packed fruit. The pupae are usually found

* Report on Insect Infestation of (Australian) Dried Fruit. Empire Marketing Board. E.M.B. 12 (1928), p. 25.

close to the outer surface of the fruit, while practically all eggs are present on the container and package, observations by Myers* having shown that pre-packing infection is relatively unimportant.

### 5. Commercial Tests.

To determine whether the bell jar tests would be confirmed, some experiments were carried out on a commercial scale. In the first case, a fumigating chamber of the type commonly attached to packing sheds was utilized. This was a wooden structure with an outer covering of tarred sheets, all openings being pasted over with brown paper during the fumigation process. After filling with dried fruit packages, marked packages and receptacles with larvae were placed in various parts of the chamber. The fumigant mixture was poured into a shallow tray at the top of the chamber, which was then sealed down for 24 hours. On opening the chamber it was found that the mixture had not completely evaporated in spite of the fact that the thermographic record within the chamber showed a maximum of 106° F. Examination of the test samples of larvae showed a very patchy distribution of lethal effect within the fumigator. This type of chamber appeared to be definitely unsuitable owing to air leaks, resulting in an irregular distribution of the gas. In order to make the tests under perfectly controlled conditions, it was decided to employ an air-tight steel drum which had been originally designed for fumigation with carbon disulphide fumigation in vacuo. The capacity of this drum was 125 cub. ft. The dosage rate was 14 lb. per 1,000 cub. ft. of free air space. The pore space per box of dried fruit was calculated from the real and apparent specific gravities and found to be approximately 33%. The drum was filled with 56-lb. boxes of currants, which were arranged on battens to allow of a free gas circulation. The required amount of fumigant was then sprayed in through two apertures in the top. Hessian had been originally placed on top of the fruit to absorb any drip from the spray. The drum was opened 22 hours later.

The results are shown in Table III.

Some infested boxes of currants were also examined and the results were in conformity with the foregoing. The temperature records during the fumigation period were as follows:—Maximum, 92° F.; minimum, 68°; weighted mean, 79°.

### 6. Summary of Conclusions and Recommendations.

(1) The fumigant mixture—ethylene dichloride 3 parts, and carbon tetrachloride 1 part by volume—when used at the rate of 14 lb. (5 quarts) per 1,000 cub. ft. at temperatures above 70° F. for a period of not less than 22 hours in perfectly air-tight compartments, practically sterilizes dried fruit in so far as infestation with *Plodia interpunctella* is concerned. (The same result might reasonably be anticipated with *Ephestia cautella*, which reacts similarly to *Plodia*).

(2) To ensure satisfactory results in practice, it is absolutely essential to use air-tight compartments. Very few of the fumigators at present in use in the Mildura district would satisfy this requirement.

* Report on Insect Infestation of (Australian) Dried Fruit. Empire Marketing Board. E.M.B. 12 (1928), p. 31.

(3) The packed fruit should be set on battens to allow of a free circulation within the compartment.

(4) The best results are given when the mixture is sprayed in through apertures in the roof.

TABLE III.

*Results of Commercial Scale Tests.*

| Test Samples (19.1.29). | Remarks. |
|---|---|
| (i) Small boxes 4″ x 4″ x 6½″ were packed with sultanas heavily infested with *Plodia* larvae and some *Silvanus* larvae— | |
| (*a*) Box placed at top of drum (29.1.29) | Practically 100% kill. Only 1 *Plodia* larva found alive |
| (*b*) Box placed half way up (29.1.29) | 100% *Plodia* kill; 15 live *Silvanus* larvae found |
| (*c*) Box placed at bottom (29.1.29) .. | 100% *Plodia* kill; many small *Silvanus* larvae. (Obviously the *Silvanus* larvae had hatched out of eggs which had survived fumigation) |
| (ii) Small tins each containing 25 *Plodia* larvae were exposed as follows :— | |
| (*a*) At the top .. .. .. | 100% kill |
| (*b*) Three-fourths of the way up .. | 100% kill |
| (*c*) Half way up .. .. .. | 100% kill |
| (*d*) At the bottom .. .. .. | 100% kill |
| (iii) Four 56 lb. boxes of currants were selected, and in the centre of each of these were pressed three lots of 25 larvae enclosed in the small receptacles mentioned earlier. The boxes were re-pressed and nailed down— | |
| (*a*) At the top of the drum— | |
| 22.12.28 .. .. .. | 70% dead; 30% still alive |
| 20.1.29 .. .. .. | All dead |
| (*b*) Three-fourths of the way up— | |
| 22.12.28 .. .. .. | 80% dead |
| 20.1.29 .. .. .. | 96% dead; 4% pupated |
| (*c*) Half way up— | |
| 22.12.28 .. .. .. | 90% dead |
| 20.1.29 .. .. .. | All dead |
| (*d*) At the bottom— | |
| 22.12.28 .. .. .. | 95% dead |
| 20.1.29 .. .. .. | All dead |

NOTE.—It will be seen that a varying percentage survived for some time after fumigation. Such larvae exhibited, from the outset, some signs of reflex movement, principally in the head region, and maintained a normal body turgidity and colour for some days. Larvae destroyed by fumigation shrivelled and blackened within a short period. With the exception of the 4 per cent. of larvae in (iii) (*b*), which later pupated, all died within ten days. There were no signs of any delayed revival of larvae recently noted by Hamlin and Reed (*Journal of Economic Entomology*, 21 (1928), p. 783) to occur after disulphide fumigation. These workers noted that certain larvae, at first immobile, may later revive and actually reach the adult condition. In the above experiments with ethylene dichloride—carbon tetrachloride—no evidence of any delayed revival was found.

# Meat Preservation Committee

## (of the Australian National Research Council and the Council for Scientific and Industrial Research).

## Report of Committee for the year ended 30th June, 1929.



### 1. Constitution of Committee.

Early in the period under review, the Council for Scientific and Industrial Research suggested to the Australian National Research Council that the services of Mr. Empey, B.V.Sc., who had been employed by the Committee from funds made available by the Council for Scientific and Industrial Research, should be transferred from the Committee to the Council. This proposal was put forward in view of certain developments that had taken place in connexion with the Council's investigations on cold storage problems. The matter was referred to the Committee, and it was subsequently arranged that the Committee would function as a joint body of both Councils.

During the consideration of the above, various members pointed out that the constitution of the Committee was such that it could furnish advice on the storage of all varieties of animal flesh. It was accordingly decided to recommend that its name be altered to the Meat Preservation Committee (of the Council for Scientific and Industrial Research and of the Australian National Research Council).

### 2. Appointment of Investigator.

Subsequent to the above arrangements being made, consideration was given to the position of the Committee's investigator, Mr. W. A. Empey. When originally appointed to carry out investigations on behalf of the Committee, Mr. Empey was seconded from the Victorian Department of Agriculture for twelve months. At the end of that period he was again seconded, but it was evident that this procedure could not be continued indefinitely. With a view to adjusting the matter, the Council for Scientific and Industrial Research has appointed him as a permanent officer under section 14A of its Act. He will continue to work under the aegis of the Committee.

### 3. Results of Investigations.*

*Brine Freezing of Fish.*—Investigations on the Ottesen Process for the rapid freezing of fish were concluded, and a complete report has been published in the *Journal of the Council for Scientific and Industrial Research*, Vol. 2, No. 2, May, 1929.

*The Composition of Muscle Juice and of "drip."*—Small pieces of beef taken from the muscle have been frozen and thawed at various rates and the drip (collected in rubber bags) compared with muscle juice in respect to solid, water, ash, and nitrogen content, together with viscosity, surface tension, freezing point, and refractive index.

* For previous reports on the work of this Committee, see the *Australian Journal of Experimental Biology and Medical Science*, Vol. 3 (1926), pp. 15, 81, and also the annual reports of the Australian National Research Council.

In previous experiments, it was found that muscle juices varied according to the degree of pressure applied to cut muscles, and that the greater the pressure the higher the water content, and the lower the protein and refractive index of the juice pressed out. The reason for this is probably that, in the application of a high pressure, additional water is pressed out from unbroken fibres, with consequent dilution of the juice from the fibres which have been previously cut, while a low pressure is not sufficient to affect the unbroken fibres in this manner.

The theory held regarding "drip" is that, in slow freezing the water passes out from the fibres to freeze into large ice crystals outside and between bundles of fibres, and that, on thawing, the water which has been frozen out is not completely re-absorbed into the fibres. It would be expected that, as a result, drip would contain a higher percentage of water than ordinary muscle juice, and that it would more closely resemble high-pressure than low-pressure juice. Our experiments have shown, however, that drip from slowly-frozen beef is practically identical in every respect with low-pressure juice obtained from the same muscle. This evidence would suggest that the water frozen out from the fibres is re-absorbed on thawing, this re-absorption being sufficiently complete to render drip and low-pressure muscle juice indistinguishable.

Histological evidence supports the assumption that the water frozen out from the fibres is re-absorbed, for frozen sections cut from pieces of slowly-frozen beef muscle were thawed and examined microscopically during the thawing process, when it was observed that, as the large ice crystals gradually diminished in size, the fibres, which were previously compressed into bundles between these ice crystals, resumed what was apparently their original shape and size. There were no indications that the fibre walls had been ruptured, but, nevertheless, cut portions of the same muscle dripped freely on thawing.

The theory commonly held is that the large ice crystals formed in slow freezing cause rupture of the sarcolemma, and consequent loss of drip on thawing; but, if the fibre walls have been broken, drip should be noticeable before the fibres are cut. It has not been found possible, however, to obtain drip from a whole-thawed muscle until cut surfaces are exposed. Histologists describe the sarcolemma as being an extremely resistant elastic membrane, and our evidence does not support the theory that rupture can be caused by ice-crystal formation.

The main factors influencing the flow of muscle juice, from the cut surfaces of muscle fibre, would be the viscosity and surface tension of the juice itself, the surface tension existing between the juice and the fibre wall, and the elasticity of the fibre wall and of the connective tissue holding the fibres together. These factors would also apply to the flow of drip from the cut surfaces of a thawed muscle. We have shown that the viscosity and surface tension of drip are identical with that of muscle juice, so it appears that the main changes which have taken place in freezing are in the sarcolemma itself. It is possible that the surface tension, previously existing between the contents of the fibre and the sarcolemma, has been lessened by molecular changes involving alteration in the elasticity of the latter, possibly as a result of the pressure exerted by the large ice crystals. That some such change has occurred is indicated by the fact that thawed muscle is very susceptible to pressure or compression, and a bigger percentage of muscle juice can be pressed out in a given time from it than from portions of the same muscle before freezing.

In the comparative estimation of drip it was found necessary to take uniform portions of the same muscle, for differences were evident in percentage drip from different muscles even from the same carcasses. The differences noted could probably be accounted for in the variation in the length of the individual fibres from different muscles, and it is possible that the relatively small drip from mutton may be accounted for by the relative shortness of mutton fibres as compared with those of beef.

*Freezing Point of Beef Muscle.*—With the object of fixing a limiting temperature for the storage of ice-free chilled beef measurements of the freezing point of muscles of ox, cow, and bull beef were taken with a Beckmann freezing thermometer. The lowest recorded freezing point was 29.97° F., and the highest recorded 30.36° F.

## 4. The Freezing of Prime Beef.

In June, 1929, a previous proposal of the Committee, namely, that an experimental consignment of prime beef, in the frozen condition, be sent to Great Britain, was revived. One of the members of the Committee, Mr. G. Lightfoot, had discussed the proposal during a visit to England, and had ascertained that the authorities of the British Food Investigation Board were quite in sympathy with the suggestion. Steps are now being taken to obtain two pure bred and prime bullocks of each of three breeds, namely, Polled Angus, Shorthorn, and Hereford. These bullocks will probably become available to the Committee in September, 1929. In the meantime they will be specially fattened by feeding on concentrates, &c. In September, it is intended to slaughter them, and to experiment on the hindquarters only. One hindquarter of each animal will be frozen, and the other chilled. After a period of some six weeks, the meat will be thawed, and the two pieces from each beast compared with one another from all points of view, but particularly from that of their eating qualities. Tests of the cooked material will be made by individuals not knowing which material is which, and their comments obtained and collated. Similar tests will be carried out in England after the hindquarters of the second beast of each breed have arrived in that place. In this way, it is hoped to test along lines that can readily be duplicated on a much larger commercial scale, a previous finding of the Committee that young and prime beef does not suffer by freezing to anything like the same extent as older material of poorer quality. It is also hoped to demonstrate that there are distinct possibilities in the development of an export trade in frozen beef, provided that the material exported is young and of prime quality.

## 5. Acknowledgments.

Acknowledgment must again be made of the generous assistance afforded the Committee by several bodies and individuals. The Melbourne University continued to accommodate the investigator in the laboratories of the Biochemistry School; the Victorian Department of Agriculture continued to supply many facilities at its Cool Stores, Victoria Dock, free of charge; and the Council for Scientific and Industrial Research provided the salary of the investigator and funds for the purchase of necessary apparatus.

In conclusion, the Committee again wishes to thank Mr. J. Hepburn, Works Engineer and Manager of the Victoria Dock Cool Stores of the Victorian Department of Agriculture, for the large measure of help he has continued to afford.

# The Prevention of Tuberculosis in Cattle.

## Further Investigations to Determine the Value of the B.C.G. Vaccine for the Prevention of Tuberculosis.

*By Professor H. A. Woodruff, M.R.C.V.S., and T. S. Gregory, B.V.Sc., Veterinary Research Institute, University of Melbourne.*



In concluding our preliminary report* of investigations to determine the value of B.C.G. for the prevention of bovine tuberculosis, it was stated that a number of calves had been vaccinated with B.C.G. and their resistance to infection with virulent tubercle bacilli subsequently tested by intravenous injection of the latter. Further details of this work and some later tests of a similar nature are given hereunder.

### 1. Test No. 1.

This was commenced immediately on receipt of a culture of B.C.G. and before exact instructions as to dosage and preparation of the vaccine had been received.

Three calves—Nos. 1, 2, and 3—each aged about two months were inoculated with 25 mg. of B.C.G. vaccine subcutaneously in the dewlap. The dose of vaccine used was half the minimal amount recommended by Calmette and its preparation was not in exact accordance with his method. As a result of inoculation, small subcutaneous nodules were produced which, after a period of about one month, could be easily palpated; they varied from the size of a walnut to that of an acorn. The calves maintained excellent growth and were in prime condition when submitted to test inoculation twelve months later.

In this first test, the material used for intravenous injection was not a simple emulsion of a culture of virulent tubercle bacilli but was a preparation obtained from lung tissue of a calf in which miliary tuberculosis had been experimentally produced—as a result of intravenous injection of virulent bovine tubercle bacilli 28 days previously. This animal was killed "in extremis" and some of the infected lung was ground with sterile powdered glass in a mortar; sterile saline was then added and the strained supernatent fluid used for inoculation; 5cc. of this fluid, estimated to contain 100 million virulent bacilli, were inoculated into the jugular vein of the B.C.G. vaccinated calves Nos. 1, 2, 3 and the unvaccinated control No. 64.

Within seven days, Nos 1 and 3 and control No. 64 were showing slight symptoms of respiratory distress, whilst a marked rise of temperature, accompanied by a distressing cough and loss of appetite, quickly ensued. On the 29th day after the test inoculation, calf No. 1 was killed "in extremis", while No. 3 and control No. 64 died on the 31st and 37th day respectively. In all three, post-mortem examination revealed miliary tuberculosis of the lungs, which were almost solid, and extensive tubercular changes in the mediastinal glands which were tremendously enlarged and caseous.

* This Journal, 1 (1928), p. 158.

There now remained in this group only calf No. 2, which developed a slight cough about 14 days after the test inoculation but maintained a normal appetite. The temperature later reached 105 deg. F. and there was a period of respiratory embarrassment, but six weeks after the test inoculation, the temperature, respiration and appetite were once more almost normal. The animal appeared to recover completely and fattened at pasture. Five and a half months after test inoculation, it was slaughtered and a post-mortem examination made. The greater portion of each lung appeared at first sight normal, but closer scrutiny, however, revealed minute tubercles scattered throughout. In the posterior portions, especially on the left side, were several tubercular areas 2 to 3 inches in diameter, gritty and dry on section. The prescapular, axillary and prefemoral lymphatic glands appeared normal but the bronchial and mediastinal glands, though practically normal in size, contained calcified dry lesions of tuberculosis. There were a few tubercles in the portal, internal iliac and mesenteric lymphatic glands, and in the kidneys. The liver and spleen showed no macroscopic abnormalities.

Microscopic examination of sections of material taken at the autopsies of Nos. 1, 2, 3 and 64 revealed the typical histology of tuberculosis with giant cell formation and the presence of numerous acid fast bacilli.

TEST NO. 1.

Three calves vaccinated with B.C.G. One control unvaccinated.

| Primary vaccination with B.C.G. | | Test Inoculation with virulent Tb. | Death. | | | | |
|---|---|---|---|---|---|---|---|
| No. | Age. | Length of period following B.C.G. vaccination. | Age. | Cause. | Interval between Date of Test and Date of Death. | Lesions of Tb. |
| | | | yrs mths. | | | |
| 1 | 2 months | 12 months | 1 1 | Killed "in extremis" | 1 month | Miliary Tb. and lesions of lymphatic glands |
| 2 | 2 months | 12 months | 1 6 | Killed .. | 5½ months | Lungs mostly resilient. Several calcified Tb. areas. Calcified lesions in lymphatic glands |
| 3 | 2 months | 12 months | 1 1 | Died .. | 1 month | Miliary Tb. and lesions of lymphatic glands |
| 64 | Unvaccinated control | 12 months | 1 1 | Died .. | 1 month | Miliary Tb. and lesions of lymphatic glands |

*Discussion:*

This first test did not indicate any appreciable resistance to infection with virulent tubercle bacilli, on the part of calves vaccinated with B.C.G. Though one vaccinated calf survived whilst the single control died, no definite value could be placed on this test, since all the recommended conditions for vaccination were not strictly carried out, and the severity of the test inoculation, in terms of minimal lethal doses, had not been determined.

## 2. Test No. 2.

In this test, nine calves were inoculated, within 14 days of birth, with from 50 to 100 mgms. of freshly prepared B.C.G. vaccine. There were no ill effects following vaccination, the only lesion in each calf being a small subcutaneous nodule at the site of inoculation. Twelve months after the vaccination of the first calf, the whole group of nine was submitted to a test inoculation with virulent tubercle bacilli. With these nine were placed three control calves which had not been vaccinated with B.C.G. and had failed to react to a tuberculin test.

A suspension of the organisms for intravenous injection was prepared by weighing out material from the surface growth on Dorsets egg medium and grinding in a sterile mortar with one or two drops of sterile bile, then diluting with one in 10,000 sodium carbonate solution so that 3 cc. of the final mixture contained 1 milligram of the bacilli. In the published reports of Calmette and his collaborators, a dose of 5 mg. of tubercle bacilli (Vallée strain) was used for testing. With our local virulent strain (F1), prepared as described above, the minimal lethal dose is considerably less than 1.0 mg. As there is some difficulty in deciding what is a fair test dose, the animals in this test were divided into three sub-groups each of which consisted of three B.C.G. vaccinated calves and one non-vaccinated, tuberculosis-free control. The test doses inoculated into these sub-groups A, B, and C were 1.0, 0.33 and 0.1 mg. respectively.

Following the test inoculations, a daily record of temperatures was kept and abnormalities in respiration and appetite noted as they became apparent.

*Results of the Test Inoculation.*

*Sub-group C.* (Test dose 0.1 mg.).—It was found that the temperatures of calves Nos. 8, 10 and 12 and control No. 62 remained practically normal over the period of observation, and appetite and respiration were normal.

*Sub-group B.* (Test dose 0.33 mg.).—With calves Nos. 4, 9 and 17 and control No. 68 there was a slight irregularity in the temperatures of the B.C.G. vaccinated members but the deviation from normal was never great. The control, however, after maintaining a normal temperature for eighteen days, showed a very marked rise coincident with the onset of respiratory symptoms. This rise in temperature became increasingly accentuated until it reached 107 deg. F. shortly before the death of the animal, which occurred 60 days after the test inoculation. The vaccinated calves Nos. 4, 9 and 17 showed no marked clinical signs of disease during the period of observation.

*Sub-group A.* (Test dose 1.0 mg.).—With calves Nos. 5, 7 and 16 and control No. 69, there was an irregularity of temperature with Nos. 5 and 7 which was not serious, but in the case of No. 16 and the control No. 69, respiratory symptoms and a rise of temperature were soon evident. Emaciation and a distressing cough followed and the deaths of No. 16 and control 69 occurred 40 and 60 days respectively after the test inoculation. Calves Nos. 5 and 7, on the other hand, showed no noticeable clinical symptoms and made satisfactory growth and increase in weight during the period of observation.

Generally reviewing the results of the test inoculation in the three sub-groups, it is to be noted that little practical importance can be

attached to Sub-group C since the unvaccinated control neither died nor showed clinical symptoms of tuberculosis. However, the possibility of individual resistance should be borne in mind, especially since later tests showed that 0.1 mg. of this strain of virulent tubercle bacilli constitutes a lethal dose for some calves whilst a minority withstands it. Clinical symptoms being insufficient ground on which to base an opinion of the value of B.C.G. the calves were slaughtered at various times and submitted to post-mortem examination. The results under the two headings are as follows:—

1. *Clinical Symptoms.*

Six B.C.G. vaccinated calves in Sub-groups A and B were tested with doses of virulent tubercle bacilli which killed control unvaccinated animals in 42 and 60 days respectively. Five of the vaccinated calves survived and fattened without showing any markedly abnormal symptoms and the sixth (No. 16), which was the youngest submitted to the test, died of miliary tuberculosis after 40 days. Three vaccinated calves of Sub-group C survived the test without showing the slightest symptom, as did also the unvaccinated control.

Therefore, as judged on clinical symptoms and power of survival, vaccination with B.C.G. conferred on the majority of the calves a marked protection against infection with tuberculosis by the intravenous injection of virulent tubercle bacilli.

2. *Post-mortem Findings.*

In all the Sub-groups, the only B.C.G.-vaccinated calf which died was No. 16, and post-mortem examination showed that death was due to miliary tuberculosis. The lungs were almost solid and mediastinal and bronchial lymphatic glands were tuberculous, tremendously enlarged and caseous.

In Sub-group B, control No. 68 died 42 days after the test inoculation and the post-mortem examination revealed lesions of miliary tuberculosis. At this time, the vaccinated members of the sub-group appeared quite healthy and it was decided to kill one of them (No. 4) in order to obtain a comparison with the control. There were marked differences in the post-mortem appearances. The B.C.G.-vaccinated calf was in prime condition and only on close examination were abnormalities consisting of nodules, smaller in size than a millet seed, discovered in the sub-pleural tissue of the lungs. Macroscopically, there were no lesions in the lymphatic glands or other organs. This, of course, was in marked contrast with the unvaccinated control which died of miliary tuberculosis and showed very extensive lesions. It was found on microscopic examination that the minute sub-pleural nodules in the vaccinated calf were discrete tubercles containing a few tubercle bacilli, whilst, in the control, innumerable bacilli were present in sections of lung and lymph glands.

Five months after the test inoculation, the sub-groups were as follows:—

*Sub-group A.* (Test dose 1.0 mg).—

Control No. 69—Died after 60 days. Lesions of miliary tuberculosis.
No. 16—Died after 40 days. Lesions of miliary tuberculosis.
No. 7—Living and apparently healthy.
No. 5—Living and apparently healthy.

*Sub-group B.* (Test dose 0.33 mg.).—

Control No. 68—Died after 42 days. Lesions of miliary tuberculosis.
No. 4—Killed after 42 days. Minute discrete tubercles in the lungs.
No. 9—Living and apparently healthy.
No. 17—Living and apparently healthy.

*Sub-group C.* (Test dose 0.1 mg.).—

Control No. 62
No. 10
No. 8
No. 12
} All living and apparently healthy.

Since at this date none of the members of Sub-group C had shown any symptoms, it was decided to reduce this group to the same size as the others by killing the control No. 62 and the vaccinated calf No. 10. On post-mortem examination, the control showed numerous minute tubercles scattered throughout the lungs, and the bronchial and mediastinal glands, though not perceptibly enlarged, contained calcified lesions of tuberculosis.

The B.C.G. vaccinated calf No. 10 showed no lesions macroscopically, either in the lungs or lymph glands, nor could any changes indicative of tuberculosis be seen on microscopical examination of sections. An emulsion of portion of the glands, however, was inoculated subcutaneously into guinea pigs, which died from generalized tuberculosis after four months. This case is similar to some described by Calmette and Guerin, who demonstrated that apparently normal lymph glands may, by animal inoculation, be shown to contain virulent tubercle bacilli for a period as long as eighteen months after test inoculation.

There were now two B.C.G. vaccinated calves left in each subgroup and, in view of the above post-mortem examinations, it was thought desirable that one out of each pair should now be submitted to post-mortem examination. Nos. 7, 8 and 9 were chosen.

No. 7 of Sub-group A (Test dose 1.0 mg.) revealed extensive lesions on the surfaces of the costal and parietal pleurae consisting of soft velvety brown granulomatous patches of tubercular tissue. The pericardium was similarly affected. Scattered throughout the lungs, which were otherwise resilient, were a number of yellow caseous tubercles the size of grains of wheat. On the peritoneum were found granulomatous lesions and there were some adhesions between peritoneal surfaces and viscera; there were four or five small tubercles in the liver but the spleen and kidneys were unaffected. There were tubercles in the superior cervical lymphatic glands on the side of the test inoculation whilst the mediastinal and bronchial glands were slightly enlarged, fibrous, and contained a few millet seed tubercles. The remaining lymphatic glands appeared normal. The subcutaneous nodule in the dewlap resulting from the original B.C.G. vaccination was about the size of a hazel nut and consisted of purulent material enclosed in fibrous tissue. Microscopical examination of a smear of this pus showed a number of acid fast bacilli presumed to be the B.C.G. strain. An emulsion of this pus inoculated subcutaneously into guinea pigs failed to produce tuberculosis or any other ill effects.

## Test No. 2—Sub-group A.

Three calves vaccinated with B.C.G. One calf (control) unvaccinated. Test dose of virulent tubercle bacilli, 1·0 mg.

| Primary vaccination with B.C.G. | | Test Inoculation with virulent Tb. | | Death. | | Interval between Date of Test and Date of Death. | Lesions of Tb. |
|---|---|---|---|---|---|---|---|
| No. | Age. | Interval preceding. | Dose. | Age. | Cause. | | |
| 69 | Unvaccinated control | ... .. | 1.0 mg. .. | yrs. mths. 1 6 | Died .. | 60 days .. | Lung almost solid with miliary Tb. Tb. of mediastinal and bronchial glands, which were tremendously enlarged and caseous |
| 16 | Several days .. | 5 months .. | 1.0 mg. .. | 0 6½ | Died .. | 40 days .. | Miliary Tb. Tb. of bronchial and mediastinal glands similar to control No. 69 above |
| 7 | Several days .. | 11 months .. | 1.0 mg. .. | 1 4 | Killed .. | 5 months.. | Widespread Tb. lesions of pleural and peritoneal surfaces in lung. Mediastinal and bronchial glands slightly enlarged and containing millet seed tubercles (c.f. No. 8, Group III.). ( No. 9, Group II.) |
| 5 | Several days .. | 11 months .. | 1.0 mg. .. | 1 9 | Killed .. | 9½ months | Lung appeared normal. Tubercles and caseation in the submaxillary, prescapular, prefemoral, portal, internal iliac, mediastinal, and bronchial glands |

### Sub-group B.

Test dose of virulent tubercle bacilli, 0·33 mg.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 68 | Unvaccinated control | .. .. | 0.33 mg. | 1 6 | Died .. | 42 days .. | Lung almost solid with miliary Tb. Tb. lesions in bronchial and mediastinal lymphatic glands |
| 4 | Several days .. | 12 months .. | 0.33 mg. | 1 1 | Killed .. | 42 days .. | No gland lesions. Minute pin head tubercles in lung |
| 9 | Several days .. | 10 months .. | 0.33 mg. | 1 3 | Killed .. | 5 months.. | Widespread Tb. lesions of pleural and peritoneal surface small tubercles in lung. Mediastinal and bronchial glands somewhat enlarged and containing caseous areas. Single tubercles in several other glands |
| 17 | Several days .. | 5 months .. | 0.33 mg. | 1 2 | Killed .. | 9½ months | One or two costo-pleural adhesions, six "grape" tubercles along border of one lung. Remainder of lungs appeared normal. Tubercles in mediastinal and bronchial glands |

## Test No. 2—Sub-group C.

Three calves vaccinated with B.C.G. One control calf unvaccinated. Test dose of virulent tubercle bacilli, 0·1 mg.

| Primary vaccination with B.C.G. | | Test Inoculation with virulent Tb. | | Death. | | Interval between Date of Test and Date of Death. | Lesions of Tb. |
|---|---|---|---|---|---|---|---|
| No. | Age. | Length of period following B.C.G. Vaccination. | Dose. | Age. | Cause. | | |
| | | | | yrs. mths. | | | |
| 62 | Unvaccinated control | .. .. | 0.1 mg. .. | 1 6 | Killed .. | 5 months.. | Minute tubercles throughout lung. Bronchial and mediastinal glands all contain calcified Tb. areas, though they are not enlarged |
| 10 | Several days .. | 10 months .. | 0.1 mg. .. | 1 3 | Killed .. | 5 months.. | A suggestion of minute spots on pleural surface of lung. No gland lesions |
| 8 | Several days .. | 10 months .. | 0.1 mg. .. | 1 3 | Killed .. | 5 months.. | No lesions |
| 12 | Several days .. | 9 months .. | 0.1 mg. .. | 1 6 | Killed .. | 9½ months | Lung appears normal except for one or two pleural adhesions. Sub-maxillary glands contain tubercles also the mediastinal and bronchial lymph glands |

No. 9 of Sub-group B (Test dose 0.33 mg.) showd practically the same lesions as the above animal, No. 7.

No. 8 of Sub-group C (Test dose 0.1 mg.) showed no lesions either macroscopically or microscopically.

Therefore, with these three calves, No. 8 completely resisted infection with a test dose of 0.1 mg. of virulent tubercle bacilli whilst in Nos. 7 and 9 (which received doses of 1.0 and 0.33 mg. respectively) widespread lesions of tuberculosis were found on post-mortem though they appeared normal to ante-mortem inspection.

Nine and a half months after test inoculation, each sub-group had one surviving member. All three had thrived and two of them appeared normal to clinical examination whereas the third, No. 5, was found to have definitely enlarged submaxillary and prefemoral lymphatic glands. The three animals were then submitted to post-mortem examination.

No. 5 (Sub-group A: Test dose 1.0 mg.) was found to have tubercles throughout most of the lymphatic glands. One submaxillary gland was enlarged and caseated, whilst the prescapular, prefemoral, portal, internal iliac, mediastinal and bronchial glands all contained tubercles. The liver, spleen, lungs and serous membranes were not affected.

No. 17 (Sub-group B: Test dose 0.33 mg.) had a few pleural adhesions, but the lung tissue appeared normal. Lesions of tuberculosis were found in the submaxillary, mediastinal, and bronchial lymphatic glands.

No. 12 (Sub-group C: Test dose 0.1 mg.) had small tubercles in the mediastinal and bronchial lymphatic glands. There were a few pleural adhesions and half a dozen "grape" lesions of tuberculosis along the free border of one lung. The lung tissue itself appeared normal.

Emulsions made from the mediastinal glands of these three animals, when subcutaneously injected into guinea-pigs, killed the latter with generalized tuberculosis in from four to five months.

*Discussion:*

Generally reviewing the results of this test, in which all the stipulated conditions were observed, it is necessary to compare, from several points of view, the fate of the controls and the vaccinated calves.

In Sub-groups A and B, which received the larger test doses, the controls died in 60 and 42 days respectively. Of the six B.C.G.-vaccinated calves, one died in 40 days, whilst the remaining five survived without showing any serious symptoms of disease.

In Sub-group C, neither the control nor vaccinated calves showed any reaction. It may be said, therefore, that from the clinical aspect the B.C.G.-vaccinated calves had shown a marked resistance to infection.

Consideration of post-mortem examinations shows that the unvaccinated controls of Sub-groups A and B died from tuberculosis of a miliary type in the lungs and an extensive affection of the lymphatic system. One B.C.G.-vaccinated calf died and showed similar lesions, but the remainder of the B.C.G.-vaccinated animals were killed

at various periods after test inoculation, and although definite lesions of tuberculosis were revealed, generally speaking their nature was such that the lives of the animals did not appear to be endangered. In Sub-group C very few lesions were found, and the control showed little more than the B.C.G.-vaccinated animals. It may be said, therefore, on a consideration of the whole test, that the post-mortem comparison was markedly in favour of the B.C.G.-vaccinated calves.

### 3. Test No. 3.

*Preliminary:*

In order to re-determine the minimal lethal dose of our virulent strain (F1), six calves, after having been submitted and found negative to a tuberculin test, were inoculated with 1.0, 0.5, 0.33, 0.2, and 0.1 (two calves) mg. of virulent bacilli respectively. Five of the six died in from six to fourteen weeks with tuberculosis, the last two being those which received the smallest dose (0.1 mg.). The single survivor was that one which received 0.5 mg., and individual resistance was the only explanation for its survival.

Fearing that the subsequent test might be upset by the presence of resistant controls it was decided to use at least 0.5 mg. as a test dose, although this amount may represent at least five minimal lethal doses.

For this third test eight calves were inoculated within a few days of birth with from 50 to 100 mg. of B.C.G. vaccine. The typical subcutaneous nodule resulted, and there was no setback as the result of the inoculation. The calves were inoculated at different times so that at the time of test inoculation they varied in age from three to ten and one-half months. The suspension of virulent tubercle bacilli was prepared as in test No. 2, and 0.5 mg. was injected into the eight B.C.G.-vaccinated calves, Nos. 20, 21, 22, 23, 24, 25, 26, 33, and three tuberculosis-free unvaccinated controls Nos. 34, 35, and 36.

As a result of test inoculation, there was a rise in temperature of all the animals on the two ensuing days, but they then returned to normal. Twenty-one days after inoculation No. 33 developed tympanitis and died suddenly. Up till this time it had shown no ill effects as the result of the test inoculation, and its temperature had been normal. On post-mortem examination, the lungs were found to be resilient, but minute congested areas throughout indicated the location of the injected bacilli; the mediastinal and bronchial glands were enlarged. The liver was fatty, and there was a marked enteritis. The brain and other organs showed no trace of tuberculosis. It was considered, in view of the normal temperature of the animal and the post-mortem findings, that death was most probably caused by enteritis and tympanitis of dietetic origin.

A fortnight after the test inoculation all the animals in the test, except No. 33, showed some slight clinical symptoms.

The B.C.G.-vaccinated calf No. 24 started coughing after sixteen days, and its temperature rose to 107 deg. F., and continued well above normal until it died eight days later. Post-mortem examination revealed miliary tuberculosis of the lungs and enlargement and caseation of the bronchial and mediastinal lymphatic glands.

## Test No. 3.

Eight calves vaccinated with B.C.G. Three calves (controls) unvaccinated. Test dose of virulent tubercle bacilli, 0·5 mg.

| Primary vaccination with B.C.G. | | Test Inoculation with virulent Tb. | | Death. | | Interval between Date of Test Inoculation and Date of Death. | Lesions of Tb. |
|---|---|---|---|---|---|---|---|
| No. | Age. | Interval preceding. | Dose. | Age. | Cause. | | |
| | | | | yrs. mths. | | | |
| 34 | Unvaccinated control | .. .. | 0.5 mg. .. | 1 2 | Died .. | 26 days .. | Miliary tuberculosis |
| 35 | Unvaccinated control | .. .. | 0.5 mg. .. | 1 2 | Died .. | 24 days .. | Miliary tuberculosis |
| 36 | Unvaccinated control | .. .. | 0.5 mg. .. | 1 2 | Died .. | 26 days .. | Miliary tuberculosis |
| 21 | Several days .. | 10½ months.. | 0.5 mg. .. | 1 0 | Died .. | 44 days .. | Miliary tuberculosis |
| 24 | Several days .. | 7 months .. | 0.5 mg. .. | 0 8 | Died .. | 24 days .. | Miliary tuberculosis |
| 25 | Several days .. | 7 months .. | 0.5 mg. .. | 0 8 | Died .. | 28 days .. | Miliary tuberculosis |
| 33 | Several days .. | 3 months .. | 0.5 mg. .. | 0 4 | Died .. | 21 days .. | Minute congested points throughout lungs which were resilient. Enlarged mediastinal glands. (Death apparently due to other causes) |
| 20 | Several days .. | 10½ months.. | 0.5 mg. .. | 1 6 | Killed .. | 221 days | One small tubercular abscess in lung |
| 22 | Several days .. | 8 months .. | 0.5 mg. .. | 1 3 | Killed .. | 232 days | Old pleural and peritoneal adhesions with small tubercular granulomata. Two small abscesses in lungs |
| 23 | Several days .. | 8 months .. | 0.5 mg. .. | 1 5 | Killed .. | 257 days | One small Tb. abscess in lung. Tubercles in mediastinal and bronchial lymph glands |
| 26 | Several days .. | 7 months .. | 0.5 mg. .. | 1 3 | Killed .. | 240 days | Small calcified tubercles in mediastinal, bronchial, mesenteric, and portal lymphatic glands. Two small calcified lesions in lungs |

The unvaccinated control No. 35 died on the same day, that is, 24 days after the test inoculation, having shown similar clinical symptoms, and the post-mortem examination showing similar lesions.

The two remaining unvaccinated controls, Nos. 34 and 36, died on the 26th day after test inoculation, after having shown marked respiratory symptoms and emaciation. Lesions of miliary tuberculosis were found on post-mortem examination.

The B.C.G.-vaccinated calf No. 25 died two days later, that is, 28 days after test inoculation, the history and post-mortem findings being similar to the above controls.

With No. 21, the progress of the disease was slower, but after showing high temperatures and respiratory symptoms, death ensued 44 days after the test inoculation as a result of miliary tuberculosis.

B.C.G.-vaccinated calves Nos. 20, 22, 23, and 26 all showed abnormal temperatures and mild clinical symptoms, but after 60 days their temperatures returned to normal and they appeared to have overcome the infection. These animals were then turned out to pasture with the intention of keeping them for an extended period before slaughter, but as it became necessary to terminate this research the period was shortened to one of about eight months.

On post-mortem examination of No. 20, killed 221 days after the test inoculation, a single small abscess the size of a pea containing tubercular pus was found in one lung. Otherwise the lungs and other organs appeared normal on macroscopic examination. The animal before slaughter was in good condition and appeared perfectly healthy.

No. 22, which also appeared to be healthy on ante-mortem inspection, showed on post-mortem examination signs of an old standing pleurisy and peritonitis. A number of small granulomatous tubercular lesions were present on the peritoneal surface of the spleen. No tubercles were found in the lymphatic glands. Two small tubercular abscesses were found in the lungs.

Nos. 23 and 26 also appeared to be in excellent health and were in fat condition. On post-mortem examination, the former was found to have a small tubercular abscess the size of a coffee bean in the lung and tubercles in the mediastinal and bronchial lymph glands. Calf No. 26 had two calcified lesions the size of a millet seed in the lungs, and small calcified tubercles in the mediastinal, bronchial, mesenteric, and portal lymphatic glands.

*Discussion:*

In this third test eight calves which had been vaccinated for various lengths of time and three tuberculosis-free unvaccinated controls were submitted to an intravenous test inoculation with virulent tubercle bacilli.

One of the vaccinated calves died from causes other than tuberculosis, and post-mortem indications suggested that the latter infection might not have proved fatal.

The three unvaccinated control animals died within 27 days after inoculation. Of the vaccinated calves, three died from miliary tuberculosis, whilst four survived.

In this test it was found necessary to use a dose of virulent tubercle bacilli known to be greater than the lethal dose for the average animal of the size of those in the test. All the controls died as the result of the test inoculation.

The net result of the test is clearly in favour of the B.C.G.-vaccinated calves.

## 4. Summary and Conclusions.

In experimental work with B.C.G., a number of calves have been inoculated subcutaneously with amounts of up to 100 mg. of B.C.G. None of these animals has shown any ill-effects, and the only lesion produced in each was a small nodule which varied in size, and after twelve months had disappeared or remained only as a small fibrous tissue encapsulation of pus containing acid fast bacilli. Therefore the vaccine used as recommended is, in our experience, innocuous.

Twenty vaccinated calves were tested by intravenous inoculation of virulent tubercle bacilli to determine their resistance toward virulent infection. Six of these B.C.G.-vaccinated calves died as a result of extensive tuberculosis in about the same time as control unvaccinated animals. Of the remaining fourteen, some showed clinical symptoms of infection, but later returned to normal.

These surviving animals were subsequently slaughtered and some lesions of tuberculosis were found in the majority, but they did not indicate a progressive infection.

It will be seen, in considering each test individually, that, both by clinical and post-mortem results, B.C.G. vaccination does confer some degree of resistance toward infection with virulent tubercle bacilli.

It must also be recognized that in work of this nature there is extreme difficulty in determining a sufficient yet reasonable dose of virulent bacilli for test inoculation. The interim report of Watson* on his experiments on calves indicates the tremendous variation in susceptibility, both in individual animals and in different herds, to virulent infection. Watson also points out that many authors have claimed that two to three milligrams of virulent tubercle bacilli inoculated intravenously into calves a few months of age will cause death from generalized tuberculosis in two or three months or less, but he has not found this to be the case. Even the Vallée strain of virulent tubercle bacilli appeared to be of very low virulence in his experiments. The strain which we have used was isolated from a tubercular gland taken from the carcass of an ox at an abattoir, and the experiments described indicate that 1.0 mg. and even much smaller quantities will certainly cause death in from one to three months after intravenous inoculation. The virulence of the original strain has been maintained in subcultures, differing very slightly if at all from those of the same strain which have undergone passage through a susceptible animal.

Generally reviewing these tests, and after careful consideration of the attendant difficulties, it may be said that B.C.G. vaccination afforded a certain amount of resistance toward infection with virulent bacilli. The innocuity of the process of vaccination having been

* *Journal of the American Veterinary Medical Association* **71** N.S. **24**, No. 6.

demonstrated, it has now been considered advisable to submit the method to the fairest test, namely, its power of protecting against virulent infection under field conditions. A number of herds known to be highly infected with tuberculosis have been chosen, and the majority of calves will be vaccinated shortly after birth and re-vaccinated annually. A number will be left unvaccinated as controls. More than 200 calves have been inoculated up to date without any death or setback being produced as a result.

### 5. Further Experimental Inoculation Studies in Laboratory Animals.

It was concluded in our preliminary report that B.C.G. in massive doses was innocuous for guinea-pigs, rabbits, sheep, and fowls. These experiments were confined to the inoculation of massive doses by the subcutaneous route. The reports of the majority of workers agree with regard to subcutaneous inoculation, but attention has been drawn to the fact that guinea-pigs, intraperitoneally injected with massive doses, may develop tuberculous lesions which are later overcome. Kraus, among others, has carried out a number of experiments in this regard, and he concluded as a result that B.C.G. possesses a certain virulence for experimental animals, and that in a given period after inoculation tubercular lesions are produced. He stated that lesions in the organs seldom result from the subcutaneous inoculation of large quantities of B.C.G., but as a result of the intraperitoneal injection of 5 to 20 mg. of culture, there may be produced a localized tuberculosis of the omentum and rarely nodules in the spleen and liver. These lesions could be seen by macroscopic and microscopic examination to possess all the attributes of a tubercular process. The essential difference between the lesions of virulent tuberculosis and those produced by B.C.G. was the property of the latter to localize and subsequently completely heal. Reinoculation of lesions produced by B.C.G. into healthy animals failed to produce any lesions in the latter. Kraus and his collaborators concluded that B.C.G. has undergone a lasting modification, so that it now possesses only a very slight virulence, and to this latter property, and not to a total avirulence, do they attribute its immunizing properties.

In continuation of our work on laboratory animals a series of guinea-pigs was inoculated with from 5 to 20 mg. of B.G.C. intraperitoneally. All the animals remained healthy, but on post-mortem examination several of them revealed small nodules in the omentum and occasionally some peritoneal adhesions. No nodules were found in the spleen or other organs. The omental lesions contained a small quantity of pus in which microscopic examination revealed the presence of acid fast bacilli. A preparation was made from these lesions and injected intraperitoneally into healthy guinea-pigs and rabbits. No lesions were found as the result of reinoculation in any of these animals when they were killed at various periods after injection.

Rabbits which were injected intraperitoneally with large doses of B.C.G. failed to show any lesions on post-mortem examination, but intravenous inoculation of from 5 to 10 mg. resulted in the formation of small nodules in the lung. These follicles were barely perceptible on macroscopic examination, but on microscopic examination were

found to be composed of epithelioid cells. There was no caseation and no tubercle bacilli were seen. The health of the rabbits was not affected.

These experiments confirm the results of workers who have found that B.C.G. injected in massive doses may produce lesions of a tuberculous nature which undergo subsequent retrogression.

At no time during this work have massive doses of B.C.G. produced a progressive tuberculosis infection in calves or smaller animals of the laboratory, nor have nodules present in these animals as the result of B.C.G. vaccination ever produced lesions on reinoculation into healthy animals.

---

# The Refrigeration of Fish.

*By W. J. Young, D.Sc., and W. A. Empey, B.V.Sc.*

*ERRATUM.*

An error occurs in the first page of this article which appeared in the previous issue, p. 87. In paragraph 2, "Freezing", it was stated that "the brine was kept at 8° F." Actually this should have read, "the brine was kept at minus 8° F".

# The Sulphuring of Dried Fruits.

**At the present time, British Health Regulations do not permit the importation into Great Britain of dried apricots, peaches, pears, &c., containing more than 14 grains of sulphur dioxide per lb. It has been found, however, that some samples of such fruit dried in Australia contain more sulphur dioxide than the maximum amount permitted under these regulations. The problem has been investigated from time to time by officers of the State Departments of Agriculture concerned, and by officers of the Commonwealth Research Station, Merbein. As a result, much information of value is already available. With a view mainly to arranging for co-ordination in any future work that might be undertaken, the matter was discussed with the Chairman of the Standing Committee on Agriculture (Dr. S. S. Cameron), and at his suggestion a meeting was held in Melbourne in June last, when the officers concerned were in that city in connexion with the annual conference of State Ministers of Agriculture. The following report was furnished by the meeting. The recommendations it contains have been approved by the Council and by the three State Departments of Agriculture concerned, and steps are being taken to give effect to them.—Ed.**

The meeting was held on 11th June, 1929, and following days. It was attended by:—

Mr. Geo. Quinn, Chief Horticultural Officer, Department of Agriculture, South Australia.

Mr. C. G. Savage, Director of Fruit Culture, Department of Agriculture, New South Wales.

Mr. W. R. Jewell, Research Chemist, Department of Agriculture, Victoria.

Mr. A. V. Lyon, Officer-in-Charge, Commonwealth Research Station, Merbein.

*Terms of Reference.*

1. To discuss the difficulty which has arisen in the past with respect to the sulphur dioxide content of dried fruits.

2. To endeavour to arrive at agreement regarding the procedure for the coming season.

3. To make arrangements for the carrying out of any experimental work that may be considered necessary.

*Resolutions.*

1. The Committee is satisfied that the present somewhat irregular methods of sulphuring adopted by growers for sulphuring dried stone fruits tend to over-sulphuring of the product. This is particularly true in the case of apricots.

No uniformity in respect to sulphuring methods exists. Growers' methods vary in such important particulars as—

(*a*) duration of exposure to sulphur fumes;

(*b*) quantity of sulphur used;

(*c*) type and size of sulphur chamber adopted;

(*d*) maturity of fruit.

As regards over-sulphured apricots of the 1928-29 season, experimental work conducted at the Research Station, Merbein, and by Mr. Jewell, indicates that excess sulphur dioxide can be reduced to below

14 grains per lb. by a treatment with hydrogen peroxide solution. This treatment has been carried out on a commercial scale by a packing shed at Mildura and apparently has no deleterious effect on the fruit, although sufficient time has not elapsed to show whether the fruit will retain its colour.

Mr. Jewell has prepared a report on this process and this Committee recommends that this report be published in the *Journal of the Department of Agriculture, Victoria*, and that copies be forwarded to other members of this Committee for publication in their respective Agricultural Journals. For further action see under (3) (*a*) later.

2. It is considered that while existing data are insufficient to establish absolutely conclusive recommendations, it is sufficient to enable recommendations to be made which, in the case of apricots, might reasonably be expected to give a satisfactory product in most instances. The sulphuring of pears and peaches does not offer any serious difficulties. The recommendations in regard to apricots are:—

(*a*) *Maturity.*—It is essential that all fruit be picked "eating ripe" and that, when cutting, all firm or over-ripe fruit should be put to one side and either discarded or sulphured separately so that all the fruit in one chamber may be of uniform maturity and, therefore, yield a uniformly sulphured product. It is recognized that firm fruit absorbs sulphur less readily than ripe.

(*b*) *Type of Chamber.*—It is recommended that an airtight chamber be used, the covering of which should be of some light material, e.g., "malthoid." In the case of movable hoods, every precaution should be taken to prevent ingress of air at the base of the hood, as for example, by using compacted, moist earth around the bottom.

A number of small airtight chambers is recommended in preference to one large one so that fruit shall not be held for any length of time after cutting and before sulphuring. For example, when using 6 feet x 3 feet trays the size of the chamber should be sufficient to accommodate a stack of about fifteen trays with a clearance of about 6 inches between the trays and the sides and top of the chamber. Trays should be staggered 6 inches when stacking.

Two controllable vent holes, 1 inch diameter and about 1 foot apart, should be provided in the roof of the chamber close to the wall furthest from the sulphur fire when one fire is used, or in the centre of the roof where a fire is used at each end of the chamber.

A movable vent-glass is a desirable adjunct in order to view the conditions inside the chamber and to test the condition of samples of the fruit.

(*c*) *Quantity of Sulphur.*—7-8 lb. of sulphur per ton of fresh cut fruit should prove ample and it is essential that the sulphur be dry in order to burn readily. The sulphur pit should preferably be located just outside, at one, or both, ends of the chamber, with a free entrance into the chamber and adequate provision for closing the air inlet after the vents are blocked. Use a minimum amount of inflammable material to light the sulphur and when fumes are issuing freely from the vents close the latter with tightly fitting corks.

The weight of fruit in a charge should be calculated by weighing the quantity of pitted fruit on two or three trays, thus obtaining the average per tray and the total weight per charge. Calculate the amount of sulphur necessary, weigh this and measure the volume in a container. Thereafter, it would be sufficiently accurate to measure the same volume of sulphur each time a similar number of trays are sulphured.

(*d*) *State of Fruit.*—It is desirable to sulphur as quickly as possible after cutting, preferably within two hours. (Hence the desirability, under 2 (*b*), of a number of small chambers.)

Fruit should be stacked from the bottom upwards in the order in which it is cut. Freshly cut fruit absorbs sulphur dioxide more readily than that cut some time prior to sulphuring, and this arrangement of stacking allows the driest fruit to be in contact with the maximum density of warm sulphur fumes, thus tending to uniform sulphuring results.

(*e*) *Period of Exposure.*—Under average summer day temperatures, four to six hours exposure to the sulphur fumes is considered sufficient to preserve the colour without over-sulphuring. The practice of leaving the fruit in the sulphur chamber overnight is not advocated as it frequently results in over-sulphuring. If it is found essential to sulphur overnight, the vent holes should be opened at the end of three hours.

(*f*) *Characteristics of Sulphured Fruit.* -The filling of the cups with juice is not necessarily a reliable indication of satisfactory sulphuring, as fruit in this condition may frequently be over-sulphured.

Correctly sulphured fruit is usually characterized by a firm core, an easily detachable skin with some exudation of juice into the cup and a general evenness of colour of the cut surface. The fruit is usually over-sulphured if the whole of the flesh has become softened, and if the cups have overflowed with juice.

(*g*) *Conclusion.*—It is suggested that these recommendations be printed by each Agricultural Department interested and circulated among growers, some months prior to the commencement of next season's operations.

3. It is considered that further experimental work is desirable to secure additional information on the points indicated below.

(*a*) *Sampling and Analysis.*—It is essential in the first place, if results in different States are to be co-ordinated, that uniform methods of sampling and analysis be adopted and that samples be analysed at some definite time after sulphuring. It is recommended that Mr. Jewell draft methods of sampling and analysis and determine time of sampling and forward copies to each member of the Committee who will see that this procedure, subject to any agreed modification, is adopted in all analytical work in connexion with these investigations.

(*b*) *Over-sulphured Apricots.*—On receipt of Mr. Jewell's report on processing over-sulphured fruit, each member of this Committee will arrange to process over-sulphured apricots according to the recommendations in that report and hold the treated fruit in storage under commercial conditions to ascertain its general keeping qualities.

(*c*) *Variety of Fruit.*—Different varieties of apricots in a similar condition of maturity are to be sulphured under similar conditions, i.e., using same chamber, number of trays, weight of sulphur, time of exposure, &c., to ascertain the relative absorption of sulphur dioxide by different varieties. If any variety appears to require any modification of the recommended treatment, further experiments are to be conducted with this variety to determine accurately such modifications. This work to be conducted by the New South Wales Department of Agriculture.

(*d*) *Effects of Temperature, including Artificial Heating.*—One variety of apricots in a similar state of maturity to be sulphured under varying atmospheric temperatures and under varying temperatures controlled by artificial heating, temperatures to be measured at three different levels inside the chamber. All other factors, including size of charge of fruit, to remain constant so that effects of temperature alone may be determined. This work to be conducted by the South Australian Department of Agriculture.

(*e*) *Quantity of Sulphur and Period of Exposure.*—Using one variety of apricot in a similar state of maturity, the quantity of sulphur and time of exposure to be varied, all other factors including chamber and weight of fruit to remain constant. The amount of sulphur remaining unburnt to be deducted from the amount weighed originally. It is suggested that using, say, 8 lb. of sulphur per ton of cut fruit the following times of exposure be tried, viz., 2, 4, 6, and 8 hours; and that, adopting an exposure of six hours, the quantity of sulphur be varied using 4, 6, 8, and 10 lb. per ton. These experiments are designed to decide definitely the optimum quantity of sulphur and time of exposure to be employed in commercial sulphuring. This work to be conducted by the Commonwealth Research Station, Merbein, working in conjunction with the Victorian Department of Agriculture and the New South Wales Fruit Instructor at Curlwaa.

(*f*) *Quantity of Fruit in Relation to Capacity of Chamber,*—Using the same number of trays and the same weight of similar fruit and similar sulphuring conditions, the size of the hood to be varied so as to allow 3, 6, 12, and 24 inches clearance over stacked trays. In all other respects, sulphuring to be in accordance with recommended procedure. This work to be conducted by the South Australian Department of Agriculture.

(*g*) *Reduction of $SO_2$ on Storage.*—Sample of next season's crop to be taken by each member of this Committee immediately at the conclusion of drying, and stored under commercial storage conditions. These samples to be analysed 3 weeks, 4 weeks, 6 weeks, 2 months, 3 months, 6 months, 9 months, and 12 months after date of sulphuring to determine reduction of $SO_2$ on storage. Details as to variety, method of sulphuring, date of sulphuring, date of termination of drying to be kept with each sample, which should weigh about 14 lb. If desirable, duplicate samples may be forwarded to Mr. Jewell for storage and periodical analysis in Melbourne.

(*h*) *Moisture on Cut Surface.*—Three trays of each of the following treatments: (1) freshly cut, (2) cut and stood five hours, (3) sprayed with water, (4) sprayed with weak brine ($2\frac{1}{2}\%$), to be stacked in various positions in one chamber charge and the whole sulphured

according to the recommendations of this Committee. Samples to be taken immediately prior to sulphuring and moisture determined in the layer ¼ inch deep from the cut surface. Samples to be analysed for $SO_2$ after drying to ascertain effect of moisture of cut surface on absorption of $SO_2$. This work to be carried out by the Commonwealth Research Station, Merbein, in conjunction with the Victorian Department of Agriculture and the New South Wales Fruit Instructor at Curlwaa.

(*i*) *General Considerations.*—In all experimental work, full details of the whole sulphuring procedure are to be recorded including size and nature of chamber, atmospheric and chamber temperatures, hour of commencement and conclusion, time necessary to dry, &c. Each set of experiments is to be replicated preferably three times. The foregoing naturally does not limit the nature of the experimental work that any member of this Committee may desire to undertake, but each State representative assumes responsibility for the carrying out of work allotted above.

*General.*

(*a*) It is recommended that copies of these minutes be forwarded to the Departments of Agriculture interested for information and necessary action.

(*b*) It is recommended that this Committee meet next year at the time and place of the annual Ministerial Conference to discuss and co-ordinate experimental work conducted in the interim, to consider the condition of the 1929-30 crop and the efficacy of the recommended sulphuring treatments, to amend those recommendations where necessary and to consider any further work.

(*c*) It is recommended that Mr. Jewell be empowered to act as co-ordinating officer and secretary to this Committee.

# Blue Mould of Tobacco: Investigations Concerning Seed Transmission.

*By H. R. Angell, B.Sc.Agr., Ph.D, Senior Plant Pathologist, Division of Economic Botany.*



## 1. Introduction.

In January, 1929, arrangements were made with the Australian Tobacco Investigation Committee whereby the investigation of the "blue mould" disease of tobacco was to be undertaken by the Division of Economic Botany of the Council. The Research Committee of the Investigation, consisting of the Director of Tobacco Investigations and the Chief of the Division of Economic Botany, later assigned the problem to the writer.

With a view to becoming acquainted with the disease in the field, visits were paid to the tobacco-growing districts around Myrtleford (Victoria), Tamworth (New South Wales), Mareeba and Herberton (Queensland), and the Experiment Station at Wahgunyah (Victoria). During these visits, seed was collected from many farmers who had had "blue mould" during the previous season. Material from naturally-infected plants was also preserved for preliminary study of the relation of the parasite to the host.

## 2. Glasshouse Experiments—Methods and Results.

*First Series.*—The object of these two series of experiments was to determine whether or not the disease was seed-borne. Among the few dozen samples of supposedly diseased seed collected during visits to certain districts was one only, viz., Blue Prior, that was definitely known to have been from a lot from which primarily infected seedlings had first developed during the past season. Another sample that appeared to offer some promise of bearing infection was from an apparently healthy plant that had grown to maturity in a diseased seedling bed. When the capsules were young, a suspension of conidia had been applied in drops, but to all appearances, infection had not taken place. Two other samples of seed of Australian varieties were chosen at random. Seed grown in Canada where "blue mould" is unknown was used as a control.

Wooden flats 12 inches by 24 inches were filled to a depth of about 4 inches with a mixture of equal parts of sand and ordinary garden soil and thickly sown with seed of all of the selected varieties. They were then placed side by side on the concrete floor, and supplied with moisture rising by capillarity from a small pool of water kept at approximately ½ in. deep with which they were surrounded. Table No. 1 gives among other data the varieties of seed sown, their origin, date of sowing and the number of centres of infection that were evident at a glance. At the time, we did not wish to run the risk of unduly spreading the conidia while looking for hidden diseased plants in the flats that showed the disease, and consequently, if we may judge by the results of the second series of experiments, a large number of primarily infected plants must have necessarily escaped our notice. On the other hand, an extremely careful search was made of the White Burley and

Hickory Prior flats every day. The characteristic conidiophores and conidia of a species of *Peronospora* appeared in fourteen centres in the Blue Prior, nine centres in the seedlings from the seed of the inoculated plant and five centres in Warne, all on the seventeenth day after sowing. White Burley and Hickory Prior remained free from disease for eight and ten more days respectively. By that time, the seedlings in the flats first attacked were practically all dead.

As there were diseased plants growing in the garden 30 feet below the greenhouse and some 70 feet away from the flats, it seemed desirable to adopt strict measures to guard against possible infection from air-borne conidia with consequent misinterpretation of experimental results. However, there seemed to be no reason for the view that the infections obtained ten days after germination may have been due to air-borne conidia, because the control, as well as White Burley seedlings, were free from the disease on the seventeenth day and remained so for more than seven days afterwards.

*Second Series.*—The circular earthenware flats and soil used in this series of experiments were sterilized in the autoclave for 4½ hours at 10-12 lb. pressure. Flasks of water intended for watering the seed and seedlings were also sterilized at 10-12 lb. pressure for 30 minutes. The flats were sown thickly with the varieties of seed given in Table No. 2. Those sown with Blue Prior and Herberton seed were immediately covered with glass plates. The others were left unprotected from air-borne conidia until a day or two before germination, when they were covered with glass vessels which rested on the sides of the flats. At the same time, the glass plates covering the Blue Prior and Herberton seed were carefully removed and vessels similar to the others substituted immediately. As the edges of the flats were not perfectly true, there were openings in some cases as wide as 1/12 in., and extending for some inches between the flats and their covers. These we did not deem necessary to close with cotton wool since the air of the greenhouse was relatively still and therefore it was unlikely that conidia would be blown in. Besides that, their chances of infection from air-borne conidia were equal. After germination began, the flats were placed in glazed earthenware plates in which water was standing. The moisture required by the seedlings was therefore obtained by capillary action, thus obviating any necessity for opening the flats at any time. In the accompanying Table No. 2, it will be seen that the Blue Prior and Herberton seedlings were the ones that first developed the disease, and as before, on the seventeenth day after sowing. Even though conidia were present in the air of the greenhouse—the diseased seedlings of the first series of experiments were in it, and did, in fact, infect one seedling in a flat of unprotected Adcock sown on unsterilized soil at the same time as this series—we cannot ascribe the presence of the disease in the Blue Prior and Herberton flats to that source of infection for the controls remained healthy. It may be here stated that the precautions taken to guard against infection from external sources were deemed adequate. Until we are able to obtain results from further experiments, the tentative conclusion must be drawn that the primary infection obtained in these two experiments was due to the disease being seed-borne. How the disease is carried by the seed must be decided by future experiments. It is, however, worthy of note that, according to this experiment, soaking the seed in alcohol for three minutes appears to be effective in eliminating the disease. This, as well as other means of control may, after further tests, be found to be reliable. At present, the results should be regarded as indicative.

## Table No. 1.

| Variety. | Source of Seed. | Date Sown. | Date of First Infection. | No. of Days after Sowing. | No. of Days after Germination. | Centres of Infection. | Remarks. |
|---|---|---|---|---|---|---|---|
| Blue Prior .. | Wahgunyah, Victoria | 22nd March, 1929 | 9th April, 1929 .. | 17 | 10† | 14 | Seedlings from this lot of seed were the first to become infected last season at Wahgunyah. Also compare with Table 2 |
| Unknown .. | Myrtleford, Victoria .. | 22nd March, 1929 | 9th April, 1929 .. | 17 | 10† | 9 | Seed from diseased plant, capsules inoculated |
| Warne .. | Wahgunyah, Victoria | 22nd March, 1929 | 9th April, 1929 .. | 17 | 10† | 5 | As in the above, disease had spread throughout by 29th April |
| White Burley | Wahgunyah, Victoria | 22nd March, 1929 | 20th April, 1929 | 28 | 18 | 1 | Infection from air-borne conidia* |
| Hickory Prior | Ontario, Canada .. | 22nd March, 1929 | 22nd April, 1929 | 30 | 20 | 1 | Infection from air-borne conidia* |

* It is even possible that the conidia may have been transferred by us unwittingly during the daily examinations of the flats with a hand lens.
† At this stage only the cotyledons had developed, no true leaves being present.

## Table No. 2.

| Variety. | Treatment. | Source of Seed. | Date Sown. | Date of First Infection. | No. of Days after Sowing. | No. of days after Germination. | Remarks. |
|---|---|---|---|---|---|---|---|
| Blue Prior .. | None .. | Wahgunyah .. | 13th April, 1929 | 29th April, 1929 | 17 | 10 | In an area 3″ x 1½″ there were 604 seedlings, of which 14 were diseased |
| Blue Prior .. | Disinfected Abs. Alc. 3 mins. | Wahgunyah .. | 13th April, 1929 | .. | .. | .. | Remained healthy throughout the experiment |
| Unknown .. | None .. | Herberton, Queensland | 13th April, 1929 | 29th April, 1929 | 17 | 10 | Two areas 1½″ x 1½″ were marked off and the seedlings counted. There were 7 diseased out of a total of 522 |
| Hickory Prior | None .. | Ontario, Canada .. | 13th April, 1929 | .. | .. | .. | Remained healthy throughout the experiment |
| Adcock .. | None .. | Virginia, U.S.A. .. | 13th April, 1929 | 24th May, 1929 .. | 41 | 31 | Left uncovered after 30th April. Two diseased plants found on 24th May |
| Unknown .. | None .. | Herberton, Queensland | 13th April, 1929 | 7th May, 1929 .. | 24 | 14 | Germination uneven and delayed Uncovered after 30th April |

### 3. Further Evidence in Support.

*Queensland Seed-Beds.*—After these results were obtained, they were compared with the records of the appearance of the disease in the Committee's seed-beds at Mareeba, Queensland. According to these records, "blue mould" was first observed in the Dungowan seedlings grown from Australian seed. From them, it spread to the Canadian varieties. It is worthy of note that, as far as we could ascertain, the nearest diseased tobacco plants were in Herberton, some 20 miles or more away. A careful search for wild hosts in the vicinity of the seed-beds was unrewarded. It seems improbable that conidia from the Herberton plants would remain viable during the long interval that would necessarily elapse from the time of their detachment from the conidiophores until their hypothetical arrival at Mareeba. Nor can we understand why conidia should, by mere chance, fall on and infect plants in the smaller areas sown to Australian varieties and not on the relatively large area of seedlings from seed of Canadian origin. It must not be forgotten that Mareeba and Herberton are separated by a mountain range. This would tend to act as a natural barrier. Our tentative conclusion regarding the source of primary infection at the Committee's seed-beds at Mareeba, Queensland is therefore that the infection was due to diseased seed.

### 4. Present Work and Future Plans.

It is to be regretted that the weather conditions that have prevailed since these experiments were performed have not, apparently, been favourable for the normal development of seedlings nor the disease. In spite of this, further tests are being made. Plans have also been made for seed-bed tests in the field during the coming season.

### 5. Discussion.

Information obtained from growers gave the impression that primary infection of their seedlings was not in all cases likely to be due to air-borne conidia nor to the persistence of the organism in the soil. Progressive farmers have made strenuous efforts to eliminate chances of infection from these sources. There remained therefore one other probable source of primary infection—the seed. The experiments detailed in this report have demonstrated that seed from some Australian sources produces infected seedlings from which the disease spreads rapidly. Checks, in which seed from foreign sources was used, remained healthy until they were infected by conidia from the diseased seedlings grown from Australian seed. That their delayed infection could not have been due to resistance was demonstrated by their early infection when exposed to attack by air-borne conidia. Further evidence in support of this has been gathered from the results of artificial inoculation with conidial suspensions. It is obvious from these studies that if healthy seed be sown, the chances of seed-bed infection will be minimized. Possible infection from soil sources can be easily guarded against by making the seed-beds in soil on which tobacco plants were not previously grown—a practice that should be indulged in for other reasons. The chances of infection from air-borne conidia may be reduced and perhaps eliminated altogether by having the seed-beds far removed from overwintering plants and wild hosts. This is being done by progressive farmers.

## 6. Control.

Should further confirmation of the findings detailed in this report be obtained, it will be obvious that the most important, easiest, and least expensive control measure will be the sowing of seed that is free from disease. For the present season, it is suggested that as insurance against lack of healthy seedlings sufficient for growers' needs, they should sow a reserve seed-bed with North American seed, or failing this, with seed from farms in disease-free districts. It will cost very little to sow this seed and may save pounds. No seed should be planted from fields in which "blue mould" appeared last season. The seed-bed should be at some distance from those sown to ordinary Australian seed, for, should there be diseased seedlings in the latter, the former may contract the disease from stray conidia. To guard against the possibility of infection from soil sources—experiments are planned to determine if this be a factor—they should be on soil on which tobacco had not been grown recently, and preferably on new ground.

To insure a supply of clean seed of Australian varieties for future use, it is suggested that the growers should select healthy seedlings from seed-beds in which no trace of disease appears, and transplant them in a locality where they will not be liable to infection by conidia from diseased fields nor wild hosts. Until we are able to obtain experimental evidence regarding the distance from sources of conidia at which seedlings may be safely grown, it is advised that growers should have their seed plant plots on the leeward side of their fields and removed from them by a few hundred yards or more. These plots should be specially set aside for seed only. It is advised that the plants be inspected critically at intervals to make doubly certain that they remain free from infection throughout the season. This procedure may be part of the writer's programme of work at Canberra during the coming season.

## 7. Summary.

1. Visits were made to tobacco-growing districts during the past season with the object of obtaining general information that would help in formulating a plan of attack on the "blue mould" problem.

2. Experiments are recorded in which adequate controls were used which have demonstrated that diseased seedlings develop from some lots of Australian-grown seed, whereas seedlings from North American seed remained healthy until exposed to infection from Australian seedlings. Further tests are in progress.

3. The observations made at the Committee's experimental plots at Mareeba appear to be evidence in support of the results of our experiments.

4. Definite control methods are outlined based on our present findings.

# Karri Bark as a Source of Tannin.

*By W. E. Cohen, B.Sc., Officer in Charge, Tannin Extract Plant, Perth.*



## 1. Introduction.

Karri (*Eucalyptus diversicolor*) occurs in dense forest in the extreme south-west of Western Australia. The timber is extensively milled at several centres and the bark, which is very thick and dense, is wasted in the bush or is burnt at the mills. A recent investigation, under wet-season conditions, has shown that, if all the bark is recovered from the logs at the falling site, together with a proportion from the tops, approximately 24 tons of green bark would be available at the largest mill for each working day of a 26 day month, This yield is estimated for about seven months of the year, the circumstances arising during the dry months having still to be studied.

The results of analyses of karri bark that have previously been recorded have shown an extremely wide divergence. This is the result of a number of factors that must be considered when representative samples are being taken. Thus Coghill* found that the tannin content of bark samples collected from a number of localities varied from 11 to 22 per cent. of the bark (at 14 per cent. moisture). Possibly differences in locality may have accounted in some measure for this wide divergence, but recent experience has shown that the most important factor appears to be the history of the sample dating from the time the tree is felled.

In order to obtain a fair and true indication of the average tannin content of karri bark as determined by official methods of analysis, it is essential to dry immediately the samples, which must also be taken from the tree at the time it is felled. Experience has shown to date that this drying need not be complete, but that partial drying to a moisture content of about 20 to 30 per cent. is sufficient to preserve the water-soluble bodies as such, so that they may be extracted and determined in a sample suitably prepared. The drying must not be too severe, but must be carried out at moderate temperatures.

In view of these circumstances, it has not been possible, on account of the distance of over 200 miles between the Tannin Extract Laboratory and the karri bark centre, to obtain a large number of fair average samples of the dried bark, so that the average tannin content may be definitely established. Samples recently collected and properly dried have shown a water-soluble tannin content of 20 per cent. However, for the purposes of cost estimates, it is safe to assume an average tannin content of 17 per cent.

In the wet season, the green bark has an average approximate moisture content of 60 per cent. estimated on the weight of green bark. From this it is calculated that the average quantity of tanning material

* Council for Scientific and Industrial Research, Australia, Bulletin 32 (1927).

at present being destroyed or wasted is sufficient to yield daily approximately 5.5 tons of extract containing 30 per cent. tans. In view of this waste and the shortage of locally-produced tanning materials, there appears to be sufficient grounds for an investigation into the possibilities of producing karri tannin extract commercially.

### 2. Some Peculiarities and Characteristics of Karri Bark.

Reference has already been made to the fact that partial drying of green karri bark serves to preserve its content of water-soluble tannin, so that satisfactory analytical results can be obtained. The drying appears to arrest or retard a number of reactions to which the tannin is most subject in the green bark after the tree is felled. Observations have shown that green bark is readily attacked by mould; that, if it is stored in a confined space, fermentation rapidly sets in; and that, if it is exposed to air in a finely divided state, its colour changes very rapidly from cream or sometimes light pink to brown, suggesting oxidation.

Neither time nor opportunity has been found to investigate these reactions, but it is sufficient to state that partial drying of the bark arrests or, at least, retards these changes and also, that if no such precaution is taken, the water-soluble tannin content of the bark rapidly diminishes. If such material is extracted and the soluble matter determined both in the leaching liquors and in the spent material, the sum total of these will be considerably less than the original water-soluble content of the bark, by a wide margin. By storing bark in a confined space, such as an extraction vat, losses of as much as 30 per cent. of the water solubles have been sustained in the course of a few days. Since the total-solubles content is affected to the same degree as the soluble-tannin content, it is a natural deduction that the tannins have been rendered insoluble in boiling water by one or other of the above-mentioned agencies.

### 3. Application of Ordinary Extraction Processes.

Consideration of the above discussion suggests two methods by which it may be possible to extract karri bark satisfactorily:—

(i) Extraction of bark which has been partially dried at the time of stripping;

(ii) Extraction of green bark immediately after stripping.

In either case, the processing would have to be rapid, because contact with water at moderate temperatures appears to present the same difficulties as does the storage of green bark.

(i) *Extraction of Dried Karri Bark.*—Unlike a number of well known raw materials used for tanning purposes, karri bark is very thick and dense, and consequently, is not very readily dried in large quantities. The bark contracts considerably as it is dried and becomes very tough, so much so, that its behaviour when fed to a disintegrating machine resembles that of timber. In addition, the dried bark produces a large amount of fine dust during, and subsequent to, disintegration. Besides creating a nuisance, this dust represents a loss in tans if it is not recovered. The recovery alone presents difficulties and complicates manipulation and handling, because the disintegrated material

could not be discharged direct into the extraction vats. For the same size screen, dry bark crushes much coarser than does green bark. In addition, the shrinkage of dried bark renders it more difficult to penetrate with extraction liquors. Hence, as compared with green bark, the treatment of dried bark on a large scale would have to be more severe than that applied to green bark.

In the laboratory, under analytical conditions, when the dry bark is milled to pass through a 20-mesh sieve, it is readily extracted with hot water because the structure of the bark is more or less disrupted and the tannin becomes more accessible.

(ii) *Extraction of Green Bark.*—Owing to the force of circumstances prevailing, the extraction of green karri bark has been given most consideration on the plant scale trials. At the present time, there is no equipment installed at the timber mills with which large quantities of bark could be dried. Hence the tests on the dried bark have been confined to laboratory scale work. In view of the rapidity with which the bark deteriorates even while undergoing treatment, rapid methods of treatment have been employed for the extraction of the green bark. A process is described by Depassé, in *Le Cuir,* in which the raw material is subjected to an initial treatment at optimum conditions, so that all soluble material is leached from the wood or bark during the first period of contact. After this, the liquor and its solubles-content are displaced by the press leach system employing hot water. Naturally, the conditions employed during the initial treatment are such that the maximum extraction is obtained without the destruction of tans.

This process was applied to karri bark at the experimental plant. Laboratory tests had shown that karri tan was stable towards heat and that one to two hours' contact at 95° to 100° C. was sufficient to give the maximum extraction. After this, the liquor was displaced from the bark by pressing through with weak washes at or near boiling point and finally with water at the same temperature.

By this method, both in the laboratory and on plant scale, it was found possible to extract in the course of three to four hours, 85 to 90 per cent. of the soluble matter determined to be present at the time of treatment. The adoption of the method did not, however, result in the extraction of those bodies which had apparently become insoluble between the times of stripping and treatment. Consequently, if the percentage extraction were reckoned on the initial solubles-content of the bark, the results obtained were very disappointing and, at the best, did not exceed 60 per cent.

The liquors obtained in the plant, by the application of this process, contained a large proportion of sparingly-soluble tans which precipitated on cooling, rendering the liquors exceedingly turbid and very difficult to clarify. When the liquors were stored with the object of removing those sparingly-soluble bodies by sedimentation, it was found that this process was painfully slow, that internal reactions appeared to produce still more insoluble material, and that the liquors very rapidly became infected with mould. In addition, the precipitated materials constituted a fair proportion of the tans, and, consequently, the ultimate percentage extraction of soluble tans became still further decreased.

From these and other experiments that were carried out, it was concluded that ordinary processes of extraction did not lend themselves adequately to the successful treatment of green karri bark.

### 4. Application of External Reagents to the Extraction.

Laboratory experiments have shown that, when small quantities of sodium bisulphite are added to turbid karri liquors obtained by water extraction processes, the sparingly-soluble bodies are converted on heating (preferably to temperatures above 90° C.) to a more soluble form. The amount of reagent required, varied from two to three parts per thousand of liquor, depending on the strength of the liquor treated. Hence it appeared that a solution to the problem of karri bark extraction was at hand. However, the liquors so produced contained no more soluble matter than was originally extracted with hot water, and, consequently, the percentage extraction could not possibly be improved upon by the addition of reagents outside the extraction vat.

Since the bisulphite and also sulphite served to solubilise the sparingly-soluble bodies in the liquor, it was only natural to expect that they would react in a similar manner on those bodies in the bark which were rendered insoluble previous to extraction, and which the hot water had failed to recover. Laboratory trials with this in view served to show that almost theoretical extractions could be obtained by the addition of small quantities of bisulphite or sulphite of soda to the extraction liquor during the initial contact with the bark, and that most of the insoluble tannin was recovered. Subsequent tests have shown that, for laboratory scale tests, no more than two parts of the reagent to one hundred parts of bark(dry weight) are necessary. The optimum temperature of conversion appears to be 90° to 95° C. and the period of contact at this temperature need not exceed one hour.

Comparative tests between bisulphite and sulphite have resulted in favour of the former. Up to a certain proportion, there is little difference between the extractions obtained using either reagent, but at increased proportions the sulphite appears to give a slightly greater extraction but not necessarily of tans. However, all liquors produced by the sulphite reaction, whilst being clearer than those produced by bisulphite, are red in colour and impart a pink or red colour to hide substance. Experience has shown that all colours are intensified under plant conditions. For this reason, plant trials have been confined to the use of bisulphite.

At the present time, the manufacture of an experimental shipment of the extract is being carried out. For this purpose, sodium bisulphite is being employed. It is not expected that the proportion of bisulphite will exceed 3 per cent. of the dry weight of bark treated. The proportion may probably be a little in excess of that used in the laboratory, mainly on account of the excessive heating to which the liquors are subjected from day to day, owing to the intermittent nature of the plant operations.

By this process, a light-coloured, clear, liquid extract is obtained, which imparts a pale colour to hide substance, and which contains tans and non-tans in the approximate proportion of two to one respectively. This is an increase of over 30 per cent. on that obtained in liquors produced by water extraction processes.

Sufficient extract will be manufactured to constitute an experimental shipment to be given a trial by some well established tanners. During the plant-scale operations, data are being collected with which to arrive at some approximation of the cost of production.

### 5. Conclusion.

Even at this early stage, it is possible to predict that a satisfactory solution to the problem of the extraction of the tanning matter from karri bark has been obtained. A clear liquid extract with a bright colour can be produced. The process is very simple, involving open vat treatment at ordinary pressures but at elevated temperatures, and displacement of the strong liquor by the press leach system. No complicated plant, such as autoclaves, will be required and the greatest cost items at present appear to be steam, and power for disintegration purposes. It is anticipated that production costs will be sufficiently low to attract commercial exploitation of karri tannin extract and thus eliminate at least one waste from the forests of Western Australia.

# Committee on Maintenance of Standards. Final Report and Recommendations.

The Committee on the Maintenance of Standards appointed by the Council some time ago, and consisting of Professor J. P. Madsen, University of Sydney (Chairman); Marcus Bell, Esq., and N. A. Esserman, Esq., both of the Maribyrnong Research Laboratories, Department of Defence; and Professor O. U. Vonwiller, University of Sydney, has now furnished its final report and recommendations. The report is signed by the three first-named members of the Committee, in the absence from Australia of Professor Vonwiller. It appears below. At the time of this issue going to press, the report had not been considerd in detail by the Council, but in the meantime it has been decided to print the report as containing material of general interest.—Ed.



## 1. General.

1. The question of Commonwealth control of Weights and Measures came before the former Advisory Council of Science and Industry in 1919. A report was sent to the Minister stating that Commonwealth control was of very great importance to the industrial and commercial interests of Australia, and that as a first step the creation of a nucleus of a National Standards Laboratory would be necessary. In 1921, the Associated Chambers of Commerce passed a resolution urging the Commonwealth and State Governments to take action with a view to adopting uniform Weights and Measures legislation throughout the Commonwealth. This resolution was referred to the former Institute of Science and Industry, which recommended that the Institute should proceed, as funds became available, with the establishment of the nucleus of a National Standards Laboratory. As funds were not available, no further action was taken.

In 1925, the matter was again brought up by the Controller-General of Munitions Supply and by the Commonwealth Engineering Standards Association.

2. In 1926, the Council for Scientific and Industrial Research, in order to obtain advice as to the action it should take in regard to standards, convened a representative Conference. This Conference advised that the progress of Australia, its efficiency in industry, and the effectiveness of its defence system, would be handicapped if some of the facilities which other countries have in the shape of national physical laboratories, were not made available in Australia in the near future. The Conference felt, however, that the proposal to establish immediately an Australian National Standards Laboratory should be rejected, chiefly on the grounds (*a*) that in some respects such a Laboratory would be an unnecessary duplication of personnel and equipment already existing in other Australian laboratories, and (*b*) that the cost of its establishment would amount to a very large sum. The Conference advised further that to render effective the extensive and valuable work of the Australian Commonwealth Engineering Standards Association, and to provide for the sound development of technical and industrial work in Australia, it was almost imperative that immediate action should be taken in regard to the provision and maintenance of legal standards on a uniform basis throughout the Commonwealth.

3. A Committee was appointed by C.S.I.R. in 1926, and during 1927 its Chairman, Professor Madsen, took the opportunity of a visit to Europe to obtain first-hand information in regard to the question of standards and their maintenance in England, United States, Canada, and Europe, and was successful in establishing co-operative arrangements with the authorities in these countries. Careful attention was given to the whole of the technical detail of the work which was involved in such an undertaking, and a report was prepared by the (British) National Physical Laboratory setting out the details of apparatus necessary for the provision of suitable Commonwealth standards and the approximate cost. Further, the National Physical Laboratory has since been authorized by the (British) Department of Scientific and Industrial Research, to offer to carry out, free of charge, the whole of the initial standardization and verification of the standard apparatus which would be required by the Commonwealth Government, and to carry out the necessary re-verification for a period of five years also free of charge.

All standards are liable to change owing to various physical causes. Such institutions as the National Physical Laboratory, Great Britain; the United States Bureau of Standards, &c., have made it part of their regular functions to investigate these changes with the object of maintaining the necessary high standard of accuracy. In order to maintain standards in Australia, it will be necessary to arrange for a constant interchange of national standards with such Laboratories Suitable personnel and equipment must be provided for that purpose; particularly with regard to personnel, it is essential that men of very high scientific and technical standing should be entrusted with the control.

4. The Committee recommended that, as a first step, the Commonwealth Government should, under its constitutional powers, pass a Weights and Measures Act defining standards for the whole of Australia, and adopting those standards which are legalized or recognized in Great Britain. If this were done it would be necessary—

(*a*) To procure copies of the British Standards.

(*b*) To provide machinery for the copies of the British Standards to be maintained and to be verified periodically.

(*c*) To arrange for copies of the Australian national standards to be made available to the States and for such copies to be maintained.

As already stated, the National Physical Laboratory has offered to render assistance in the provision of the Australian national standards and in the work involved in their verification from time to time. As regards maintenance, the Committee appointed by C.S.I.R. recommended that this work could, with advantage, be carried out by a proper co-ordinated effort on the part of—

(i) The Laboratories of the Munitions Supply Board of the Defence Department.

(ii) The University of Melbourne.

(iii) The University of Sydney.

The Committee assumed that since the Council for Scientific and Industrial Research has, under its Act, been provided with powers and functions to enable it to carry out "the testing and standardization of scientific apparatus and instruments and the carrying out of scientific

investigations connected with standardization of apparatus, machinery, materials and instruments used in industry," the Council would naturally be the body entrusted by the Commonwealth Government with the maintenance of Australian standards.

For this purpose the Committee recommended that in the event of the work being proceeded with, C.S.I.R. should establish a Commonwealth Standards Board to direct and control this work, and further, that such a Board should form Standards Committees to deal with different sections of the work.

5. In the event of the Commonwealth passing a Commonwealth Standards or Weights and Measures Act, on the lines suggested, it is the opinion of the Commonwealth Solicitor-General that the general effect of such an Act would be that the States would simply adopt the standards prescribed by the Commonwealth, and would continue to carry on the administration of their own Weights and Measures Acts as before, except in so far as the adoption of the Commonwealth standards might be inconsistent with their own Acts. It is not anticipated that any such inconsistency would arise.

6. The general scheme outlined in this Report has received the approval of the Institution of Engineers (Australia), the Royal Society of New South Wales, the Australian Commonwealth Engineering Standards Association and the Australian Commonwealth Association of Simplified Practice. The matter has also been brought under the attention of the Royal Commission on the Federal Constitution.

## 2. Recommendations.

It is recommended—

1. That the Commonwealth Government, under its constitutional powers, should pass a Commonwealth Standards or Weights and Measures Act, defining the Commonwealth standards and adopting those standards which are legalized or recognized by Great Britain.

2. That, in view of the fact that the Commonwealth has already, under the *Science and Industry Research Act* 1920–26, established the Council for Scientific and Industrial Research and provided it with powers and functions to carry out "the testing and standardization of scientific apparatus and instruments, and the carrying out of scientific investigations connected with standardization of apparatus, machinery, materials and instruments used in industry," the Council should be made responsible for the maintenance of Commonwealth standards.

3. That the Council should appoint a Standards Board to control, on its behalf, the work of standards maintenance, and that, for the purposes of such control and co-ordination, the Board should appoint committees of competent technical experts.

4. That the work should be subdivided in accordance with the arrangements at the (British) National Physical Laboratory under the following headings:—

(i) Metrology.
(ii) Physics.
(iii) Electricity and wireless.
(iv) Electro-technics and photometry.

5. That arrangements should be made with the following institutions for the carrying out of the work required:—

(i) *Metrology.*—The Laboratory of the Munitions Supply Board of the Defence Department.

(ii) *Physics.*—The University of Melbourne, Department of Physics.

(iii) *Electricity and Wireless.*—The University of Sydney, Department of Physics.

(iv) *Electro-technics and Photometry.*—University of Sydney, Department of Electrical Engineering.

Provided always that it be clearly understood that such arrangements are to meet the present existing needs of the Commonwealth and that they are to be made in such a manner that the whole of the work may be transferred to a Commonwealth Standards Laboratory, at such time as the Commonwealth may determine to establish such an institution.

6. The estimated expenditure of carrying out the programme recommended by the Committee is as follows:—

*Initial Capital Outlay.*

| | |
|---|---|
| Section 1—Physics .. .. .. .. | £2,000 |
| „ 2—Electricity and wireless .. .. | £1,500 |
| „ 3—Electro-technics and photometry .. | £6,000 |
| Total .. .. .. | £9,500 |

*Annual Maintenance Charges.*

| | |
|---|---|
| The equivalent of one full-time officer for each Section at a commencing salary of £500 per annum, rising to £750 per annum, | |
| The equivalent of one full-time officer for each Section at a commencing salary of £500 per annum, rising to £750 per annum, with suitable increments .. | £1,500 to £2,250 |
| One half-time secretary .. .. .. | £300 |
| Incidentals .. .. .. .. | £200 |
| Total—£2,000, increasing to £2,750 | |

In the event of it being necessary to subsidize the Department of Defence, an additional capital sum of £5,000 would be required with a further extra amount of £2,000 if it were decided to hold the Commonwealth primary standards of mass in platinum. From the point of view of the actual present practical requirements of the Commonwealth, it is doubtful whether this additional sum of £2,000 need be expended immediately. For maintenance, an additional amount of £500, rising to £750 per annum, would be required.

### 3. Industrial and Economic Importance of Maintenance of National Standards.

Modern developments in industry, commerce, and Governmental activities, have brought with them an ever-increasing need for greater accuracy in measurement and for correspondingly higher precision in the determination of standards. Industrial efficiency nowadays

depends fundamentally on the accurate control of manufacturing processes, and this control is in turn dependent on precise measurement of such matters as length, area, volume, mass, density, temperature, electrical resistance, &c. Moreover, in recent years, economical and efficient production in industry has clearly shown the necessity for expressing in precise terms the quality and performance of manufactured products, especially in the engineering industries, and this is done by the preparation and adoption of what are known as standard specifications. For the proper determination of the physical properties of the materials dealt with in these specifications, precise measurements are essential.

In Governmental activities, both in the Commonwealth and States, the part played by measurement is of fundamental importance. In the purchase of stores, the Government buys by measure, not only of size and quantity but also of quality. In many Departments, testing equipment of high precision must constantly be used. In Government services, such as meteorology, public works, surveys, geology, railways, navigation, defence, roads, &c., accurate standards of measurement are essential. In scientific work in Government Departments and branches, Universities and elsewhere, measurements of great accuracy are of course of vital consequence.

It is, therefore, a matter of importance to the industrial and economic welfare of Australia that provision should be made for securing and maintaining accurate standards of measurement on a uniform basis for the whole Commonwealth. The development and maintenance of standards of ever-increasing accuracy in order to keep pace with advancing requirements for increased precision can be carried out only by men of high scientific attainments. In spite of the fact that uniformity and accuracy are the keynotes to efficient standards of measurement, there are no national standards available in Australia. With certain minor exceptions, none of the State Governments have developed or maintained standards of a high order of accuracy. The only way in which the situation can be satisfactorily met is for the Commonwealth Government to set up and maintain national standards, to make available copies of these legalized standards, and to provide the ways and means by which comparisons can be made with the national standards.

# Radio Research Board--Annual Report.

The following is a slightly condensed form of an annual report (for the year ended 30th June, 1929) recently furnished to the Council by the Radio Research Board. The Board is constituted:—Professor J. P. Madsen (University of Sydney) (Chairman), Mr. H. P. Brown (Director and Secretary, Postmaster-General's Department), Electrical-Commander F. G. Cresswell (Department of Defence), and Professor T. H. Laby (University of Melbourne). Its main policy is that of arranging for the carrying out of the more fundamental investigations likely to yield results of value from the point of view of the improvement of the broadcasting and other radio services of Australia. Immediate problems relating to those services, problems capable of comparatively rapid solution, and, in general, all those problems which can be classified under the term "applied," are investigated by the Research Laboratory of the Postmaster-General's Department. The constitution of the Board ensures that no overlapping of its activities with those of the above Laboratory or with other researches being carried out in the field of radio by Universities, &c., occurs, but rather that all such work is co-ordinated into an effective whole.—Ed.



## 1. Investigations on Field Strengths.

The investigations being carried out by Mr. W. G. Baker at the University of Sydney and by Mr. R. O. Cherry at the University of Melbourne were continued throughout the period under review.

### (a) *Investigations at the University of Melbourne.*

The Broadcasting Company of Australia initiated research in relation to broadcasting by providing, in January, 1927, the University of Melbourne with a subsidy of £500 per annum for a total period of three years. Mr. R. O. Cherry was appointed to work under the direction of Professor T. H. Laby, and he first investigated the field intensity of 3LO Melbourne. The results he has obtained have been published in three pamphlets by 3LO in June 1927, May 1928, January 1929. In a paper now ready for publication Mr. Cherry has extended the measurement of field intensity down to fields of one millivolt per metre and has surveyed an area in all of about 10,000 square miles.

A loop aerial, condenser, and grid rectification valve voltmeter have been used in the final tests. The great advantage of this field intensity set is its portability, which diminished the cost of transport and enabled observation to be made at places inaccessible with a larger or heavier set. The apparatus used by Mr. Cherry in his field work has been checked against a more elaborate Standard Telephones and Cables Ltd. field strength set in the possession of the Postmaster-General's Department, and found to give readings not more than 4 per cent. on the high side. It is found that the principal cause of absorption in Victoria and Tasmania is that due to trees and mountains. The well known poor reception in Gippsland is due to attenuation of the waves as they pass over the tall trees and hills which are to be found between Melbourne and Gippsland. Mr. Cherry has also measured the field intensity of 7ZL Hobart, and finds marked attenuation due to forests and mountains. In such areas, a field intensity may fall from 10 millivolts per metre to 1 millivolt per metre in a distance of 10 miles.

In the second paper on the field of 3LO Melbourne, contours of the intensity of that field as observed on a hill are given, and it is found that there is a large increase in the field at the top of a hill compared with that on flat ground at the base, an effect called the "hill effect."

Mr. Cherry has observed the daylight transmission of a broadcast wave length over sea water up to a distance of 85 miles. When the large loss of intensity arising from the curvature of the earth is corrected for by Macdonald's calculations, no other losses are observed up to 85 miles, which agrees with Sommerfeld's theory of such transmission.

(*b*) *Investigations at University of Sydney.*

The investigations of Mr. Baker were initiated by the University of Sydney in January 1928, and since then Messrs. Broadcasters Ltd. (2FC) have contributed the sum of £500 per annum towards the cost of the work. Their contributions will not be renewed after the present calendar year. The investigations are being carried out under the direction of Professor J. P. Madsen, and consist of a determination of the distribution of field strengths of transmissions by the broadcasting stations 2FC and 2BL, in areas extending many miles distant from Sydney. As the work now stands, the distribution of field strengths has been determined to distances of about 60 miles from the stations. The results have brought out some interesting points, notably in connexion with the hill effect. It has also been found that going north from Sydney rapid absorption takes place over the broken and wooded country that occurs in that area. To the south, there is little absorption until the watershed is reached, when rapid attenuation takes place. At the present time, special attention is being given to a determination of the best position for a repetition of Appleton's fading experiments. It appears probable that this position will be found some 80 miles from Sydney.

During the year Mr. Baker spent some time upon the design of a special high frequency generating set and receiving set for use by the Imperial Geophysical Experimental Survey. An account of this set will probably be given in the final report of the Survey.

(*c*) *Relations of Board to Field Strength Work.*

Early in the period under review consideration was given to the relations of the Board to the above work being carried out at Sydney and Melbourne. Detailed arrangements were subsequently made, and, by mutual agreement with the Universities concerned, the scheme was put into operation on the 1st January, 1929. It provides for: (*a*) Messrs. Cherry and Baker to be appointed as part-time officers of the C.S.I.R., and to continue, under the ægis of the Radio Research Board, their previous work, the Council to provide half their salaries; and (*b*) a total amount of £1,130 to be made available by the Council (through the Board) for the purchase of apparatus, payments to part-time assistants, the cost of transport, &c.

## 2. Investigations on Atmospherics at Watheroo.

The erection of the atmospherics recorder loaned by the Board to the Watheroo Magnetic Observatory, W.A., was completed towards the end of the year 1928 at a total erected cost of £269. The instrument

that has been placed at Watheroo is similar to the one described in detail in the *Journal of the Institution of Electrical Engineers*, Vol. 64, No. 353, May, 1926, pp. 596-610. Essentially, it consists of a large frame aerial belt-driven from a turret clock, so that it completes one revolution about a vertical axis every quarter of an hour. The ends of the aerial are connected to the terminals of a valve amplifier using two stages of resistance-capacity coupled radio-frequency amplification, one detector, and two stages of audio-frequency amplification. The output from the last valve is passed through a pen writing oscillograph, the deflections of which are recorded on a cylindrical chart rotating with the aerial. The aerial is tuned to about 15 kilocycles, and thus is free from interference from transmitting stations.

Continuous recording was commenced at Watheroo on 1st November, 1928. Owing to various delays in the arrival of measuring instruments and in the necessarily slow progress in the early stages of the work, little has yet been done in the direction of the reduction of the records obtained and their interpretation.

### 3. Enlarged Programme of Research.

Early in November, 1928, the Board drew up an enlarged programme of research. It was estimated that the initial investigations would involve three years' work, and would cost £16,500. The Postmaster-General's Department has agreed to provide £8,000 of this amount, and the Council the remainder. Steps are accordingly now being taken to put the programme into effect, and, as a preliminary, advertisements have been issued in Great Britain and in Australia inviting applications for appointment to four vacant positions that have been created. The programme in question and the arrangements made for carrying it out are as follows:—

#### A. *Work at the University of Melbourne.*

(*a*) *Field Intensity Measurements.*

Measurement of the field of 3LO (and partly of 3AR) up to a distance of 20 to 30 miles (in one case to 80 miles) have been made. It is proposed to extend these in certain directions to 75 miles or more from the emitting station. The silent area at Yallourn, the hill effect, and certain other anomalous effects which have beeen noted, will be further investigated.

(*b*) *Measurement of Modulation.*

This problem will be investigated to determine the best method of making practical measurements.

(*c*) *Fading and Distortion.*

A qualitative study of fading and distortion, to be followed by an investigation on the lines of Appleton and his co-workers, will be undertaken.

(*d*) *Atmospherics.*

A study of (i) the regions of origin of atmospherics affecting South-eastern Australia; (ii) the variation of their number and intensity, both diurnally and seasonally; and (iii) their predominant characteristics, will be made.

B. *Work at the University of Sydney.*

(*a*) *Field Intensity Measurements.*

The work of field intensity measurement in the neighbourhood of Sydney, dealing particularly with radiation from the present A class stations and from Garden Island, will be continued. An investigation of the absorption effects of the Blue Mountains Range, and further investigations of the marked directive effects which have been indicated from previous observations will also be carried out.

(*b*) *Fading and Distortion.*

A qualitative study of the effects of fading and distortion experienced from the signals sent from the neighbourhood of Sydney, particularly in relation to Newcastle, will be made. Preliminary work to determine suitable sites for carrying out a repetition of Appleton's experiment in regard to the height of the Heaviside layer and the important question of the rotation of the plane of polarization of the reflected rays will be continued.

(*c*) *Atmospherics.*

A study of (i) the regions of origin of atmospherics affecting New South Wales and the Federal Capital Territory; (ii) the variation of their number and intensity, both diurnally and seasonally; and (iii) their predominant characteristics, will be made.

As regards the requirements for carrying out the above programme, it is considered that, in addition to the services of Mr. Cherry, the services of two other investigators will be necessary at Melbourne, and similarly, in the case of Sydney, two further investigators will be needed. As already indicated, these four new staff vacancies have recently been advertised. Approval has also been obtained for the purchase of initial equipment for the work to be carried out at Melbourne at a cost of up to £1,000. During the second and third years, it is estimated that the equipment required at Melbourne will involve a total expenditure of £900. For the whole three years, the travelling and transport of the three Melbourne investigators is estimated to cost £500, and the cost of maintenance (workshop, power, materials, &c.) £450 per annum. Similar expenditures are estimated in the case of Sydney.

The above programme of research is considered by the Board to be essential work which should be put in hand immediately, for the information that would be obtained would be of considerable value to the development of the broadcasting and other radio services of the Commonwealth. The Board, however, is mindful of the fact that research in directions other than those enumerated above is desirable, but it does not propose to pursue investigations into these other matters at the moment. As the occasions arise, however, further representations will be made.

### 4. Research Laboratory, Postmaster-General's Department.

The following information regarding the activities of the Research Laboratory, Postmaster-General's Department, has been furnished by H. P. Brown, Esq., the Director and Secretary of that Department. The work of the laboratory is solely the responsibility of the Department, its activities being essential to the services controlled and operated by the Department. Necessarily its work embraces radio

phenomena, but arrangements have been made so that no duplication occurs in respect of the investigations carried out under the ægis of the Radio Research Board. A short account of the work of the laboratory is included in the report of the Board, however, as it has been thought that it would be of interest to readers to have information concerning the two related activities before them.

(*a*) *Field Intensity Measurements.*

During the year field intensity measuring apparatus was mounted in a motor car and an investigation made into the magnitude of the errors that may be expected in carrying out measurements of field intensity with a portable apparatus. This equipment is capable of making measurements at considerable distances from a radio sending station. The field intensities produced in Melbourne by stations 4QG Brisbane, 2FC Sydney, and 5CL Adelaide have been measured. A number of improvements have been made to the measuring apparatus as the result of the investigations carried out upon it and with it.

(*b*) *Standard of Frequency.*

Following upon an investigation into the known methods of determining frequency, plans have been made to establish a primary standard of frequency in the laboratory. The apparatus has been ordered, and is now in the National Physical Laboratory, London, where it is being examined under the supervision of Dr. Dye. Arrangements have been made with the Melbourne Observatory to obtain accurately known time-impulses against which will be counted, by a chronographic method, the impulses from the standard frequency generator. The range of the apparatus to be installed will be sufficient to cover the gamut of frequencies utilized in telegraphy, telephony, and radio communication, up to 37 megacycles. In setting up the standard in the laboratory, facilities will be provided for propagating its frequencies to any part of the Commonwealth either by wire or radio. It is expected that the apparatus will be in constant use checking the calibration of the large number of oscillators and other devices dependent on frequency that the Department now has in operation in all States.

(*c*) *Short-wave Radio Attenuation Measurements.*

An investigation has been commenced to determine the diurnal and seasonal variations in attenuation and noise level during transmission over Bass Strait at several frequencies in the short-wave band of 40 metres to 100 metres. The information is needed in connexion with the establishment of a radio-telephone system to link the trunk lines of Tasmania with the mainland network.

(*d*) *Radio Frequency Coils and Measurement Resistance.*

An investigation was undertaken during the year into forms of fieldless reactors (inductance coils) that would be suitable for very high radio frequencies. Promising results have been obtained with a modified toroidal form of winding, and it has been found practicable to embed such a coil in a solidified dielectric and to apply a closely fitting electrostatic shield with but small increase in radio-frequency resistance, even at frequencies of 7.5 megacycles. During the course of this work valuable experience was obtained in the technique of making resistance measurements at very high frequencies. The work is to be continued.

(*e*) *Radio-frequency Wave-form.*

Experiments have been made with methods of obtaining a linear time base for the cathode-ray oscilloscope, to facilitate the examination of the wave-form. Satisfactory results at audio-frequencies have been obtained with a method that has no inherent frequency limitation; therefore, its successful use at radio-frequencies seems probable, and work is to be continued into this field.

(*f*) *Response Characteristics.*

The laboratory has made quantitative investigation of the response characteristics of modulating and de-modulating systems, electric wave filters, resonant circuits, amplifiers, &c. Such investigations are now a regular part of the laboratory work.

(*g*) *Attenuation Equalization.*

Work has been done on methods of equalizing the attenuation of lines used for the transmission of programmes for radio-broadcasting. As a result of this work, designs have been developed for equalizing networks. This is in preparation for the great extension that will take place in programme transmission as the National Broadcasting Service develops.

## 5. Publications.

The following publications have been issued as a result of the work already carried out by Messrs. Cherry and Baker, most of it prior to the Board's co-operation:—

R. O. Cherry—

Signal Strength Measurements of 3LO Melbourne.

Signal Strength Measurements of 3LO Melbourne, Paper II.

The Daylight Transmission of Wireless Waves over Sea Water.

Static and Fading Tests.

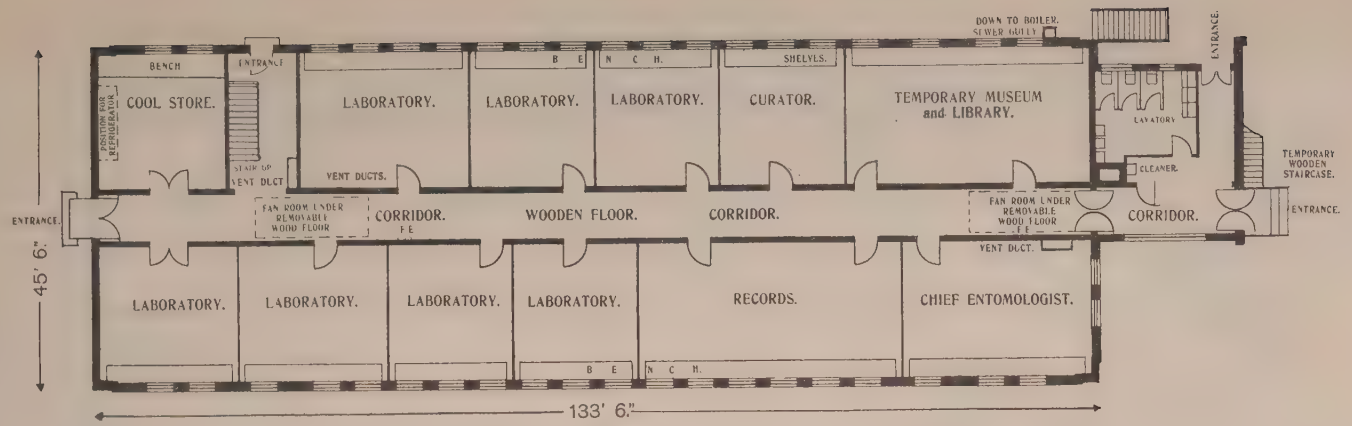
W. G. Baker—

The Design of High Frequency Transformers. *Journal of The Institution of Engineers, Australia,* Paper No. 5, Vol. 9 (1928).

(With L. S. C. Tippett). Radio Broadcast Transmission in the Neighbourhood of Sydney—Preliminary Account. *Journal of The Institution of Engineers, Australia,* Paper No. 6, Vol. 9 (1928).

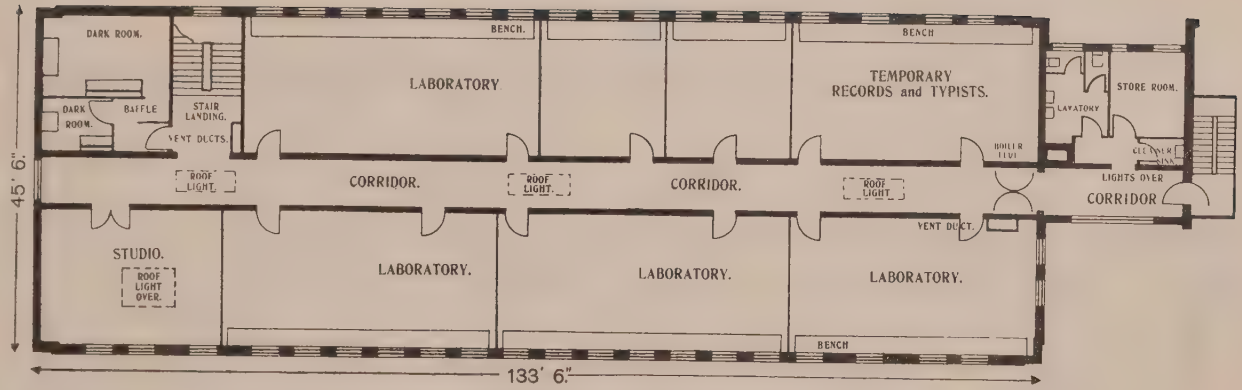
## 6. Acknowledgments.

The work of the Board has been greatly facilitated by the kind co-operation furnished by several bodies. The large measure of co-operation afforded by the Postmaster-General's Department has been described above. The Board desires to acknowledge its appreciation of that assistance, as well as the valuable help being afforded it in the shape of accommodation, &c., by the Universities of Sydney and Melbourne. It is also grateful for the large measure of co-operation that has been offered to it by the Department of Defence and by other organizations concerned with radio.




GROUND FLOOR PLAN.

PLATE 1.




FIRST FLOOR PLAN.

PLATE 2.

# NOTES.

## The Biological Control of Insect Pests—A Success in Fiji.

On many occasions, it has been pointed out that the investigations to be undertaken by the Division of Economic Entomology of the Council will consist, in the main, of an examination, firstly of the possibilities of controlling insect pests by other beneficial insects which prey upon them, and secondly, of the possibilities of controlling noxious weeds by varieties of insects which feed on these weeds only and not on other plants likely to be of economic value. The Division will, therefore, always be interested in the collection of insects from countries outside Australia, and which previously did not exist in Australia. After having been subjected to extensive tests in order to ascertain whether they will attack plants of economic value, such tests, of course, being carried out under close quarantine, the insects proving satisfactory from all points of view will then be liberated.

So far as Australia is concerned, a typical instance of the value of this method of entomological or biological control is the striking success now being obtained by the Commonwealth Prickly Pear Board operating in Queensland and New South Wales on the large areas of land there affected with that particular plant pest. Some information regarding another interesting successful use of the method, however, has just become available from Fiji by the courtesy of the Government Entomologist of that place. It appears that on Vitilevu, the largest island of the Fijian group, a moth *Levuana iridescens* had been such a pest of coconuts that it had rendered the growing of this crop for the commercial production of copra impossible. In 1922, the moth spread to other islands of Fiji, notably Ovalau and Beqa where a flourishing copra industry existed, and the pest thereby threatened to spread over the whole group of islands. In 1923, a search of the islands from New Guinea to the New Hebrides was made in the hope of finding the original home of the pest, but without success. In the words of the Government Entomologist (Mr. H. W. Simmonds) :—

"Allied moths subject to parasitic attack had long been known in the East, but it was a question whether these parasites would attack *Levuana*. A promising one was *Artona catoxantha* of Java and Malaya, which was also a pest of coconuts. In 1924 an Australian entomologist, acting under instructions from this (Fijian) Government attempted to use a Tachinid parasite of this moth from Java, but failed. The following year Dr. Tothill was appointed to take charge and decided to repeat the attempt, sending the Government Entomologist to Malaya with this object in view. Shortly afterwards he was joined by an assistant. He was able to send a very large consignment of another Tachinid *Ptychomyia remota* in charge of the assistant, which reached Fiji safely, where it was found to readily attack its new host.

The control brought about has been remarkably successful, and the pest is now confined to one or two isolated localities where a somewhat peculiar equilibrium has been brought about."

## Proposed Investigations on White Ants.

It has for long been generally recognized that the annual losses caused to wood structures in Australia by white ants, borers, and rots due to fungi, amount to very considerable proportions.

The Division of Forest Products Research of the Council, however, is now engaged on the collection of details of such losses from various public utilities such as State Railways Departments, Public Works Departments, and the Postmaster-General's Department, &c. This information is far from complete, but judging from the data already collected the damage in question is perhaps even more extensive than generally believed. For instance, slightly over 2,000,000 telegraph and telephone posts have been erected in Australia to date, and of these the average annual replacements amount to nearly 70,000. When it is remembered that the average cost of each replacement is upwards of £2, the extent of the total replacement cost will be realized. Moreover, these costs are likely to increase in the future rather than to diminish, for a considerable proportion of the poles already erected have been put in place during the last ten years—corresponding to the rapid increase of the telephonic and telegraphic services of the Commonwealth—and they have not yet reached the replacement stage. Few authentic figures as to the cause of pole failures are available, but it has been estimated that while various rots perhaps constitute the most important cause, white ants are responsible for some 30 per cent.

Turning to railway sleepers, here again complete information is not yet available. In Western Australia, however, where over 9,000,000 sleepers had been laid by the year 1928, the average replacement figure is in the region of 2.5 per cent., or 225,000 sleepers (costing about 5s. each) per year. As the total mileage of railway track in Western Australia constitutes but a comparatively small portion of the track of Australia the annual cost of railway sleepers alone must, therefore, constitute a fairly serious addition to the expenditures of the Australian railway system regarded as a whole.

Other public utilities, for example, authorities responsible for harbour structures, highway bridges, &c., are, of course, facing problems of a similar nature. In addition, there is the large annual loss caused to private interests and individuals. As instances of losses of this nature, the serious damage to the tens of thousands of miles of fencing posts of Australia, and the damage to private houses, particularly in the northern parts of the Continent, may be mentioned. Comprehensive statistics regarding the private losses due to replacements are not available, nor is it probable that they ever will be. It seems very safe to assume, however, that while the losses to public utilities caused by white ants, borers, and rots are large, the losses to which private interests are put on account of similar agencies are even more so.

It is in no way intended to imply in this article that organizations and individuals in Australia who, in the course of their work are fully seized with the importance of the above problems, have not already carried out a considerable number of attempts to overcome the difficulties. On the contrary, a considerable amount of progress to that end has already been made. Information is gradually being accumulated by such agencies as to the most suitable varieties of local timbers to use for various purposes in various localities and climates, and as to simple

methods of increasing the life of such timbers, &c. A number of preservative treatments, e.g., powellizing and fluarizing, have also been evolved, but none proved sufficiently good for all purposes, and in spite of them, the losses still remaining constitute an incentive sufficient to warrant further work.

The Chief of the Division of Forest Products (Mr. I. H. Boas) has already indicated to the Executive Committee of the Council that work on the preservation of timbers will form a prominent section of his divisional activities. One phase of that work will concern white ants, and this aspect has already been discussed by Mr. Boas with officers of the Division of Economic Entomology. As a result, arrangements have been made for an officer of the Division to carry out studies on this class of insect. The officer in question is Mr. G. F. Hill, who is well known as an authority on Australian varieties of termites (white ants). An account of some of Mr. Hill's previous observations on these insects is given in a bulletin (No. 21) of the former Institute of Science and Industry. Mr. Hill has recently prepared a memorandum outlining his ideas, endorsed by Dr. Tillyard, as to the lines these new investigations should take. Attention is drawn in the memorandum to the necessity for some preliminary taxonomic work, and the probable considerable value of developing methods of keeping colonies in captivity for the purpose of carrying out preliminary tests on timber with known species. It is now becoming a well recognized fact that all species of white ants do not react alike to the different species of timber, nor to timbers treated by any particular preservative method.

Mr. Hill makes the following statements in his memorandum:—

"About 127 Australian species of termites are described, approximately 70 more are awaiting description, and without doubt many more are not as yet represented in existing collections. Some of the most destructive are amongst the 70 un-named species. Should un-named species be submitted for identification by the Forest Products Division, as is being done frequently by other organizations and individuals, it is possible at present to give only generic names, substituting numbers for specific names. The latter plan has been adopted by certain American workers with most confusing results.

"My proposal is that I should undertake a description of the undescribed species at present available, or which may become available from time to time, as a definite part of my work, so that our knowledge should be at least as advanced as is required by the Forests Products Division. Preliminary work could be undertaken concurrently with the above to determine satisfactory methods of testing colonies in captivity. At present we know practically nothing of this probably cheap and easy method of conducting timber tests. My personal view is that termites constitute a problem in the insect world second only to the blowfly in economic importance. It affects every State, with the possible exception of Tasmania, and a very wide range of interests. Unlike the spectacular outbreaks of pests such as thrips, peach aphis, grasshoppers, &c., which occur only periodically, and generally in areas in which the population is large enough to make its voice heard, termites work continuously, and their damage passes more or less unnoticed until remedial measures are hopeless. . . ."

It is of interest to note that the white ant problem has aroused concern in several countries other than Australia. In the United States, the Madison Forest Products Laboratory has recently initiated a programme of research with a view to testing the effect of treating timber with various chemicals as a safeguard against the pest. Small pieces of several varieties of American timber have been treated with chemicals in various ways and these, together with untreated pieces of the same varieties to serve as controls, have been sent to different localities in America, and also to South Africa and Australia, for embedding in white ant colonies and for the observation of the results. The Australian work has been entrusted to the Council, and will be carried out by Mr. Hill, mainly in Canberra.

---

## Caseous Lymphadenitis.

In the previous issue (Vol. 1 (1928), p. 376), a brief outline was given of investigations in progress in connexion with the problem of caseous lymphadenitis in sheep. Both before and since that time, the problem has been the subject of frequent requests to the Federal Government and to the Council by various organisations of pastoralists. Towards the latter part of February last, the matter was discussed further at a conference convened by the Graziers Association of New South Wales, and attended by representatives of the Association, of the Council and of the New South Wales Meat Exporters Association. On all such occasions, the trouble and expense caused to exporters, and through them to the pastoralists as a whole, have been stressed, and it is quite evident that the problem is an important one.

As previously indicated, the condition has already been investigated to a certain extent by various individuals and organizations in Australia. In addition to those mentioned in the former note, the New South Wales Department of Agriculture is undertaking a study of aspects of the problem at its Glenfield Research Station. Despite all these activities, however, a solution is by no means yet in sight. Incidentally too, the work indicated previously as being undertaken by Mr. T. S. Gregory has been discontinued, owing to that officer's resignation from the Council to take up a position on the staff of the University of Melbourne.

Further work is now proposed by the Council. A bacteriological technician has been appointed to assist Mr. H. R. Carne, at the University of Sydney, and thus to enable him to expedite his investigations. Mr. Carne has already carried out some work to determine whether any other organisms, in addition to the bacillus of Preisz and Nocard, are responsible for lesions classed as caseous lymphadenitis. He has also carried out a considerable amount of work on the characteristics of the Preisz-Nocard bacillus under various conditions of artificial cultivation and the differentiation of various strains by serological methods. He is now engaged on investigations, mainly along serological lines, with a view to the elaboration of an accurate method of determining whether a sheep is infected or not.

In Adelaide, a chemist has recently been appointed to relieve Mr. C. G. Dickinson (an officer of the Council working in the laboratories of the Government Laboratory of Bacteriology and Pathology,

South Australia) of chemical work in connexion with his study of bovine haematuria and thus free him to devote a much greater proportion of his time to the work on caseous lymphadenitis he is carrying out under the direction of Dr. Lionel Bull. This last consists of an inquiry into the problem of protecting animals (by vaccines) against infection by the Preisz-Nocard bacillus. A considerable amount of work of a preliminary character has been done and ground has been cleared for a more determined attack on the problem. Incidentally, the results of some of the work have shown that guinea pigs develop a disease in most respects similar to that found in sheep under natural conditions, if the guinea pigs are given by the mouth material containing live Preisz-Nocard bacilli.

In addition to the above recent appointments, the Council is now advertising for a field officer to investigate the disease in the field, and to collect specimens for bacteriological examination, with a view to throwing light on the common methods of infection.

In conclusion, the investigations will be greatly facilitated by the co-operation of several other organisations. The co-operation of the University of Sydney and of the South Australian Laboratory of Bacteriology and Pathology has already been mentioned. In addition, the New South Wales Department of Agriculture has offered assistance in connexion with an incidence survey of the condition in the field. The Department of Markets and Transport (Meat Inspection Branch) is collecting careful statistics in all the works under its inspection, and the various Graziers Associations have indicated their readiness to assist.

## The Division of Economic Entomology—Laboratories at Canberra.

The Canberra laboratories of the Division of Economic Entomology are now rapidly approaching completion, and it is expected that the actual building, as distinct from its equipment, will be finished in September, 1929. The site of these laboratories was given in a previous issue (Vol. 2, No. 1, p. 55). It was also indicated previously (Vol. 1, p. 371) that the Empire Marketing Board has agreed to contribute £25,000 on a £1 for £1 basis with the Council towards the capital cost of equipping the Division with its necessary laboratories, insectaries, apparatus, small field stations, &c., and also to contribute on similar terms an amount of about £37,000, spread over a period of five years, towards the running expenses of the Division.

The above Canberra laboratories consist of a brick and concrete two-story rectangular block, 133 feet long by 45 feet wide and about 32 feet high. Plans of the two stories are given in the accompanying plates.* The building was designed by architects of the Federal Capital Commission.

On both floors the building will be divided longitudinally by a central corridor 6 feet wide. The weight of the roof, &c., will be borne by the outer walls and by the walls of the central corridor, thus enabling the transverse partitions forming the various rooms to be

* See facing page 176.

of a light and temporary nature and capable of easy alteration to suit the requirements of the individual investigators, which will vary from time to time.

The above building has been placed on the Council's area at Canberra in such a way as to allow for its incorporation, at some time in the future, with a central administrative building and with a corresponding laboratory building for the Division of Economic Botany. The central building that has been proposed will contain the administrative offices of both Divisions and also a common library and rooms for a museum, herbarium, and records. The plans of the laboratories for the Division of Economic Botany are similar to those of the entomological wing, and when effect is given to the full scheme the completed building will contain the entomological wing (now in course of erection), the central administrative building, and the botanical wing, all in one long line running almost north and south and facing east. The insectaries and glass houses for the Divisions will be at the back of the main building.

To continue the description of the entomological wing, the building will have a flat roof, and this and both concrete floors will be covered with bituminous coverings. As at first constructed, the ground floor on one side of the corridor will consist of four laboratories, each about 18 feet by 20 feet in size, and two larger rooms, each about 18 feet by 32 feet. On the other side of the corridor, somewhat similar divisions will be made, but at one end a basement will be placed, and this will contain refrigerating facilities, so that small individual rooms in the basement may be kept at any temperature desired for the rearing of insects in various phases of their life cycles. On the first floor, the laboratories are larger, and consequently fewer in number than on the ground floor, but otherwise the arrangement is much the same. At the south end, however, there is a dark room for photographic work.

A 3-ft. wide bench of stained New Zealand kauri will run the length of the available laboratory space under the windows on each side of the building. This bench will be provided at frequent intervals with sinks, hot and cold-water taps, electric power points, and (petrol) gas taps.

## Geophysical Prospecting in Australia- Present Position.

The aims and objects of the Imperial Geophysical Experimental Survey have been described on a previous occasion (Vol. 1 (1928), p. 92). The most important of these objects is to make as thorough a test of the various methods that have been developed for prospecting by geophysical means as is possible in the time available.

At the present time, the Survey has four parties in the field. Two of these are investigating various electrical methods, and have carried out tests at Anembo and Captain's Flat, near Queanbeyan, N.S.W., at Leadville, N.S.W., at Zeehan, Tas., and at Renison Bell, Tas. The electrical parties are now located at Northampton, W.A., and Underbool (in the Mallee district of Victoria). In all the fields

examined, indications, some more definite than others, have been obtained that ore bodies exist. In the majority of cases, the findings by the different electrical methods used agree with each other, and accordingly some confirmation of the results and an idea of the value of the methods under various conditions of working have already been obtained. In order to obtain still more definite confirmations, the various State Departments of Mines concerned have agreed to co-operate in the direction of testing the findings of the Survey by means of bores.

The third party is using gravitational methods. A brown coal area at Gelliondale (Vic.), has been studied in detail, and the underground limits of the brown coal beds determined. The conclusions drawn from the gravimetric work agree quite closely to the information obtained from bore holes. The gravitational party is now at Lakes Entrance (Vic.), where it is engaged on the determination of the underground limits of a supposed buried granite ridge. The information thus obtained will be tested subsequently (by bores) in connexion with the search for oil in the area.

The fourth party is studying seismic methods. This work is being carried out at Gulgong (N.S.W.) in connexion with the search for a buried gold-bearing lead. The party has but recently been organized, and, as yet, it is too early to expect definite results from it.

The choice of the various sites of work has been made after full consultation with the Departments of Mines and the Geological Surveys of the States concerned, bearing in mind the principal object of the work, namely, a testing of methods. The State Departments have all along shown a very keen interest in the work, and have afforded valuable assistance in several different ways, but notably in the direction of arranging to test by boring the findings of the Survey. One Department has attached an officer to the staff of the Survey in order that he might obtain experience in the various methods. The British Department of Scientific and Industrial Research has similarly attached an officer.

The Survey will complete its operations by the middle of February, 1930. Before that time, however, several other areas will be tested in addition to those mentioned in the foregoing. An interesting piece of work now in progress is an examination of the electrical method from the point of view of its possible use in the search for underground water in the drier parts of Australia.

The Survey has recently suffered a very severe loss in the death of the Deputy Director, Dr. E. S. Bieler, who was originally appointed by reason of his special knowledge of the electrical method, and of his broad knowledge of geophysics in general. He was Associate-Professor of Physics, McGill University, Canada, and for some years had specialized on geophysical work. On his way through Perth to visit the electrical party at Northampton he contracted an acute form of pneumonia, and died at Geraldton (Western Australia) on the 25th July, 1929, after an illness of only two days' duration.

## The Buffalo Fly Problem.

Some information is now available concerning the early impressions of the investigators recently sent to Java and the Northern Territory in connexion with further studies of the buffalo fly problem.

Dr. Mackerras and Mr. G. L. Windred left Sydney in April last for Java. Writing under date the 12th May, Dr. Mackerras states that he has been very impressed by the remarkable rarity of house flies, stable flies (*Stomoxys*), *Lyperosia* and blowflies. Despite the existence in Java of considerable numbers of imported dairy cattle, principally Friesians, as well as the endemic buffalo and zebu, Dr. Bubberman of the State Veterinary Institute, Buitenzorg, has informed him that fly worry does not occur in the case of any of these varieties. Dr. Mackerras remarks further that with 40,000,000 people and a great many animals, both wild and domestic, there should be plenty of food for the larvae of flies, and that Java appears to be a country in which every condition appears favourable for a large number of these insects. Nevertheless, there are hardly any. Presumably, flies are kept down by parasites, and, therefore, Java seems to be a promising field for the search for fly parasites likely to be of value to Australia.

The authorities of the State Veterinary Institute have kindly placed a laboratory at Mr. Windred's disposal, and have also arranged to provide him shortly with the services of a native assistant, who worked with Dr. Nieschulz (see this *Journal,* Vol. 1 (1928), p. 289). Mr. Windred will remain in Java and carry out an active search for parasites.

Mr. T. G. Campbell left Sydney on the 7th March, 1929, for North Australia. He has already visited several inland cattle stations and travelled with beasts from these stations to Darwin. He finds that in the wet, humid areas, buffalo flies are particularly plentiful and constitute a serious pest; that the fly population of the individual beasts does not diminish very much by a train journey; and that live beasts placed on board ship still had numbers of flies on them when they left Darwin. Mr. Campbell has now arranged to travel overland along the stock routes towards Queensland in order to determine the behavior of buffalo flies that might exist on cattle travelling into Queensland from various parts of the Northern Territory. In some of the inland areas visited, buffalo flies were not very plentiful, but the nights were cold and in marked contrast to the heat prevailing in Darwin. Mr. Campbell is of the opinion that such weather conditions probably exercise a considerable limitation on the numbers and activities of *Lyperosia* during the cooler months at least.

In a report dated 10th June, he gives an account of a visit to Newcastle Waters. He there found no buffalo flies at all, although he was informed that some were present in the years 1922 and 1923. He inspected four mobs of cattle from Wave Hill on their way through Newcastle Waters to the Queensland border, and again found no trace of any buffalo flies. He was also informed that the fly does not exist at Wave Hill. He is remaining a short while at Newcastle Waters obtaining meteorological data, and obtaining information from local residents as to weather conditions throughout the year. Up to date, his inquiries lead him to believe that conditions in these inland stations around Newcastle Waters are not favorable to the development of buffalo fly.

## The Future of Beef Production.

Sir William Haldane, who is one of the members of the Development Commission of Great Britain and therefore in close touch with agricultural matters in general, has recently been discussing in the columns of the "Times" the outlook for future beef supplies. In the main, he looks at the problem from the point of view of the encouraging possibilities ahead of the local English farmer, but the information he puts forward is of general interest.

He begins by pointing out that the public of the British Isles are dependent on the Argentine for their beef supplies to the extent of 40 per cent. Evidence is accumulating in the Argentine, however, to support the conclusion that the present decline in beef production in that country will be permanent. Conditions giving rise to that position are the widespread occurrence of foot and mouth disease throughout almost the whole of the country, the breaking up of the best fattening pastures for tillage and for the production of more profitable crops, e.g., maize and other grains, and the growing use of the cattle runs for sheep, which of late years, particularly with the high prices ruling for wool, have proved more profitable than cattle. Expressed in figures, the beef exports from the Argentine in 1928 were 24 per cent. lower than the peak year of 1927, and judging from the statistics of the first three months of 1929, this rate of decline is, if anything, increasing.

Speaking of England, Sir William remarks:—"In face of the conditions affecting our Argentine beef supply, it is impossible for consumers in this country to expect in existing circumstances continuance of either the quantity, quality or low cost of the beef they have hitherto so largely fed on, but there is a further contingency that must be borne in mind, though more distant in danger. The position in the United States is now widely known as regards shortage of beef supply. It is barely 25 years since that country was pouring beef of excellent quality into our markets in copious supply, more than satisfying our needs. In cattle, population has gone down from 68 million in 1920 to 55 million now, these cattle being fewer than in any year during the last half century; and to-day the people of the great Republic, enormously more numerous, are experiencing what is described as a meat famine, their consumption having been reduced over 15 per cent. per head last year compared with two years ago."

---

## C.S.I.R. Canberra University Committee.

At the request of the Government, the Council has formed a Committee consisting of Sir David Masson (Emeritus Professor of Chemistry, University of Melbourne), (Chairman), Sir Henry Braddon (a member of the Senate of the University of Sydney), Sir Thomas Lyle (Emeritus Professor of Natural Philosophy, University of Melbourne), Sir Robert Garran (Solicitor-General) and Mr. A. J. Gibson (late Professor of Engineering, University of Queensland) with the members of the Executive as *ex officio* members, to report on the establishment of a University of Canberra, particularly from the point of view of its relation to the scientific work of the Council to be carried out in that place, and also in relation to the scientific work

of other institutions in Canberra. From this point of view, the possibilities of the establishment of a post-graduate research University are being explored.

The Committee held its first meeting in Canberra on the 24th and 25th of June, but does not expect to be able to issue its final report until after the lapse of some time.

During the visit to Canberra, much information regarding the need for under-graduate teaching in that place was obtained from the local University Association. The Association has been formed quite recently to promote the establishment of a University in Canberra, and it has chiefly in mind the teaching of some subjects of the Arts and Law courses.

## Ontario Research Foundation, Canada.

Information has just become available in Australia regarding an interesting research development in Canada. Some eighteen months ago the Premier of the Province of Ontario convened a meeting of manufacturers operating in the Province, and indicated to them that his Government would be willing to contribute towards the cost of scientific research with regard to industrial and agricultural problems of concern to Ontario as a whole. To that end, he suggested that the commercial interests of the Province should contribute up to £200,000 and promised that the Government would match such contributions by a like amount.

The response has been even better than anticipated and £400,000 has already been contributed from private and commercial sources. The objective has accordingly been raised to £500,000, which, with a similar contribution from the Government, will mean that the sum of £1,000,000 will be available.

A body known as the Ontario Research Foundation has been set up to carry out the investigations proposed. The Chairman of the Foundation is Sir Joseph Flavelle and its Director Dr. H. B. Speakman. The former has had many years of University and manufacturing experience, and the latter is a chemist who, among other experience, was very closely connected with the development of the fermentation processes evolved during the war for the production of acetone.

As to the work of the Foundation, this will be mainly in the two fields of manufacturing and agriculture. Researches concerning the woollen, the meat packing, the metal, and the leather industries are to be initiated at an early date. In addition, a very considerable amount of attention will be given to agricultural problems.

Judging from the little information that is as yet available, the constitution of the Foundation is very similar to that of the Council for Scientific and Industrial Research in Australia. Unlike the latter however, the Foundation is a body set up solely by a Province or portion only of Canada and thus corresponds to a State body in Australia. The extent of the endowment funds it has already received (from a population of 3,230,000) is therefore all the more noteworthy.

## Bitter Pit in Apples—A Confirmation of Conclusions.

In the Council's Bulletin 41, an account is given of some work on bitter pit carried out by Messrs. W. M. Carne, H. A. Pittman and H. G. Elliott, and in co-operation with the Western Australian Department of Agriculture.

In addition to constituting a comprehensive account of bitter pit and related diseases, the bulletin contains a conclusion that a particular test for determining the stage of maturity of the apple serves as a useful means of ascertaining when particular samples of fruit are likely to contract bitter pit on storage. The test in question is dependent on the use of iodine and on its effect on the starch content of the cut apples.

An interesting example of the value of the method has arisen as the result of a recent occurrence. Towards the end of February last, Mr. Carne was called into consultation by the inspecting officers concerned, in connexion with an early shipment of apples from Western Australia. After testing the fruit by the iodine method, he pronounced it as immature and liable to excessive development of pit during the storage period necessary for its export to England. For this reason, he was of the opinion that it should not be exported and in consequence, a very considerable proportion of the proposed shipment was not sent. At the time, the wisdom of this decision was seriously questioned by the owners of the fruit and their agents, particularly in its application to the variety Cox's Orange Pippin. The fruit of this variety, which is an early maturing one, was considered by the agents to be ripe enough for export.

Some growers were so convinced that the decision was wrong, that they placed a number of the rejected cases in cold storage and arranged that officers of the Department should see them opened at the time when the vessel that was to have taken them arrived in London. This was done, the fruit being taken out of cold store and examined early in April in the presence of the Superintendent of Horticulture and the agents concerned. The result showed the need for the rejection as the fruit opened up in a very badly pitted condition.

In a subsequent examination of some cases of this fruit which the owners were good enough to make available to Mr. Carne, over 90 per cent of the larger sized ($2\frac{3}{4}''$) apples were affected and while the condition was not quite so evident as this in the smaller apples, it nevertheless existed to the extent of over 70 per cent. in the 2″ sizes.

## Blackening in Canned Meat.

From time to time, canners of meat and fruit products are troubled with the blackening of their material when the tins are opened after storage. The problem has been extensively investigated in the United States, where it has caused serious losses. Information and suggestions as to how the trouble may be overcome have recently been furnished to the Council's representative in Great Britain (Mr. F. L. McDougall) by the authorities of the British Food Investigation Board. The paragraphs that follow are based on that information which incidentally has become available largely as a result of American work.

Blackening is practically always due to the formation of iron sulphide and thus is directly related to sulphide sulphur compounds produced in the food during cooking or storage. Products containing relatively large quantities of these compounds blacken, while those containing small quantities, or none at all, remain normal. Blackening generally does not occur unless the material is either neutral in reaction or alkaline. It increases with rises of temperature and consequently storage at low temperatures is one means of mitigating the trouble. It has also been found that the condition and variety of the animal affects the formation of sulphide in its flesh after death.

As to methods of avoiding blackening, it is rarely that the choice of the tinned plate, extra heavy tinning, &c., will be effective, as almost any type of tinned plate will supply sufficient iron for discoloration. With some materials, for example canned corn, it has been found that hydrogen sulphide is produced in cooking more especially in the first half-hour, and consequently this material will blacken less when given a pre-cooking at high temperatures before canning. In America, a special form of enamel for the internal coating of tins has been developed as a result of researches carried out on behalf of the National Canners Association. This enamel appears to be quite reliable with a wet pack, but it might be necessary to couple it with the use of a parchment paper lining in the case of dry packs.

---

### The Frosting of Vines—Paper by Mr. J. G. Wood.

In the early spring of the year 1927, a very severe frost occurred in the vine growing irrigation areas in the Murray Valley, and serious economic loss was caused thereby. Among other actions taken by interested organizations, the Council for Scientific and Industrial Research arranged for Mr. J. G. Wood of the Department of Botany, University of Adelaide, to visit the areas, to examine the damage, and if possible, to suggest remedial measures. Shortly after, Mr. Wood submitted a report dealing mainly with the immediate problems. He has now, however, prepared a paper dealing with the nature and explanation of the pathological symptoms he observed in the current and sultana vines at the time of his visit. It consists of a discussion, from a fundamental botanical viewpoint, of the damage caused not only to young leaves and shoots but to older wood of up to 5 years old. The full report has been submitted to the editors of the *Australian Journal of Experimental Biology and Medical Science,* and will probably appear in that publication at an early date.*

---

### Animal Diseases—Position re Sir Arnold Theiler.

In the previous issue (p. 120) it was stated that Sir Arnold Theiler was to be offered the position of Consultant to the proposed Division of Animal Health. That offer was subsequently made and for a time it was thought he would be able to accept it. Unfortunately, however,

* It appeared in Vol. 6 (1929), p. 103.

it has now proved that Sir Arnold's health is too unsatisfactory to allow of his acceptance and in consequence he will not be returning to Australia.

Consideration is now being given to the organization of the proposed Division in his absence. No very definite decisions have yet been made but the possibilities of extending the work now in progress in Sydney and Melbourne are being explored.

---

## Department of Scientific and Industrial Research, New Zealand—Bulletins.

The following additional bulletins of the New Zealand Department of Scientific and Industrial Research have just become available in Australia:—

Bulletin No. 7 by E. F. Northcroft, M.Sc., deals with the structural characteristics of New Zealand wool as determined by microscopical examination.

Bulletin No. 8 by W. Donovan, M.Sc., F.I.C., is a summary of investigations on New Zealand coal, including brown coal, and is issued under the auspices of the Fuel Research Committee of the Department. After discussing properties such as spontaneous ignition, use in gas producers, blending for use in gas work, use in railway locomotives, and low temperature distillation, the writer concludes that although considerable work has been done on some New Zealand coals, knowledge of their properties generally is very limited and should be extended in many directions. He then proceeds to indicate the directions in which such investigations should be made.

Bulletin No. 9 is a report on the relative values of high and low testing milk for cheese making in New Zealand and was prepared by T. O. Beale, B.A., M.Sc., A.I.C., Research Chemist to the Federation of Taranaki Co-operative Dairy Factories. The questions at issue concern the relative worth of cheese made from milk of high and low butter fat contents, respectively, and the equity of making payment for milk intended for cheese manufacture on a basis of butter fat content. Quoting from the foreword, these problems were some that have long concerned the dairy farmers not only of New Zealand, but of all other parts of the world where payments for milk for cheese manufacture has, for want of a better method, been made on a butter fat basis.

Bulletin No. 10 deals with the low temperature carbonization of blended New Zealand coals. It was written by W. G. Hughson, M.Sc., Assistant Chemist, Fuel Research Station, Dominion Laboratory, Wellington. It forms a record of investigations in which the Gray-King assay method as developed by the Fuel Research Board of Great Britain was used to determine the behavior of New Zealand coals when subjected to low temperature carbonisation.

---

## The Mellon Institute of Industrial Research.

The Mellon Institute of Industrial Research, University of Pittsburgh, was founded in order to provide American manufacturers with the services of a fully equipped scientific laboratory and a trained

staff for the investigation of problems arising in their industries, at an expenditure far less than would be involved in the establishment of their own private laboratories. Manufacturers are encouraged to submit their problems and when these involve research, are required to endow Fellowships for a period of one or more years for as many men as are needed to undertake the investigations. The Institute is not of a commercial nature, being entirely independent and deriving no financial profit from the investigations it conducts. All results obtained by the Industrial Fellowship belong exclusively to the donors.

A report outlining the progress made during the Institute's 18th year (which ended on 28th February, 1929) is now available. The report is a record of increased growth: at the end of the year, 62 Industrial Fellowships employing 145 research specialists and their assistants were in active operation. In support of this work the sum of £160,000, an increase of £20,000 over the preceding year, was contributed by the interested manufacturers. As instances of the successes obtained during the year, mention is made of a successful process that has been developed for the chrome plating of aluminium, and which has had wide application in industry; of an extensive investigation of kiln construction and operations for the vitrified sewer pipe industry, which has resulted in a large saving in fuel, and likewise, to an increased efficiency in operations; certain valuable contributions to the lacquer industry through the development of new solvents and resins; and to the construction of a new fertilizer plant which incorporates important advances in the technology of the fertilizer industry.

An interesting paragraph of the report reads as follows:—" Industrial history makes it clear that happy ideas and chance discoveries have not contributed materially to the progress of technology. The stimulus for development generally results from demand, and in manufactures organised on modern lines, the working out of new processes and the improvement of existing processes consist mainly in the application of scientific fact and theory, the raw material of the applied scientist and engineer. Industry, therefore, should sustain pure as well as technical research, not merely for altruistic reasons, but because research in pure science makes for progress in technology. It is noteworthy that the industries that have benefited financially from research are constantly giving more financial support to this type of a research program."

## The Downy Mildew of the Hop.

A very serious disease of the hop is at present causing heavy losses in Europe, and has now broken out in British Columbia. So far, it is not known in the hop-growing parts of Australia, but the growers will be well-advised to be on the look-out for it, and this account of the disease is presented to that end.

The fungus (*Pseudoperonospora humuli*) was first reported from Japan in 1905, and was then found in Wisconsin, U.S.A., in 1909.

It was unknown in Europe until 1920, when small and sporadic infections were observed by Professor Salmon, at Wye, in Kent. First records for Germany and Yugo Slavia were in the year 1923, but it is highly probable that it was present earlier because of its extent in 1923. How it reached Europe cannot now be ascertained, but in 1926 severe losses were experienced in Germany, and, in 1927, in England. In 1928, it was recorded from British Columbia, Canada, but again it is likely to have been present earlier.

The disease is known as "downy mildew" of the hop, and like the "downy mildew" of grapes, of lettuce, of onions, and "blight" of the potato, it requires high humidity to become epidemic.

In the severest attack, the whole crop is lost, but even in less severe outbreaks, when the cones are discoloured but not killed, the losses are still appreciable. The disease manifests itself in early spring by the development of pale-green or silvery-grey spike-like shoots arising from the crown among the normal green bines. Dark masses of spores are produced on the underside of the leaves of the diseased "spikes," and these spread among the healthy bines, thus disseminating the disease. When normal leaves are infected, yellow spots, turning brown and having an angular outline, develop, and again on the lower surface more spores are produced when weather conditions are right. Bines of 7 feet in height may be infected, in which case the tip growth becomes "spiked." The hop cones may be attacked in all stages of growth, the loss being greater the younger and more severely affected they are when the disease occurs.

Professor Salmon has found the mycelium (vegetative part) of the fungus deep down in sets.

Wild hops are commonly severely affected by the disease, and it is interesting to note that in Wisconsin, U.S.A., only wild hops have been found to be infected.

In England, Professor Salmon reports that Tolhurst, Bramling, and Prolifics are susceptible, while Fuggles is resistant, so far.

## Recent and Forthcoming Publications of the Council.

Recent publications of the Council have been—

Bulletin No. 40.—"Observations on the hydatid parasite (*Echinococcus granulosus*) and control of hydatid disease in Australia," by I. Clunies Ross, D.V.Sc.

Bulletin No. 41.—"Studies concerning the so-called bitter-pit of apples in Australia, with special reference to the variety Cleopatra" by W. M. Carne, F.L.S., H. A. Pittman, B.Sc.Agr., and H. G. Elliott, Dip.Agr.

Pamphlet No. 10.—"The health and nutrition of animals." Reports by Sir Arnold Theiler, K.C.M.G., D.Sc., and J. B. Orr, D.S.O., M.C., M.A., M.D., D.Sc.

Pamphlet No. 11.—" The Tasmanian grass grub (*Oncopera intricata* Walker)." A preliminary report on its life history and methods of control by Gerald F. Hill.

Pamphlet No. 12.—" The cattle tick pest and methods for its eradication." A report prepared by the Cattle Tick Dip Committee.

Publications which are now in the press or which will appear shortly are:—

Bulletin No. 42.—" A soil survey of Block E (Renmark) and Ral Ral (Chaffey) Irrigation Areas " by J. K. Taylor, B.A., M.Sc., and H. N. England, B.Sc.

Bulletin No. .—" The binomics of *Fasciola hepatica* in New South Wales and of the intermediate host *Limnea brazieri* " by I. Clunies Ross, D.V.Sc., and A. C. Mackay, B.V.Sc.

Pamphlet No. .—" The dairy industry of the Commonwealth in relation to possible activities of the Council for Scientific and Industrial Research " by Professor S. M. Wadham, M.A., Agr.Dip. (Camb.)

Pamphlet No. .—" The mechanical analysis of soils," by C. S. Piper, M.Sc., and H. G. Poole, M.Sc.

H. J. GREEN,
GOVERNMENT PRINTER,
MELBOURNE.

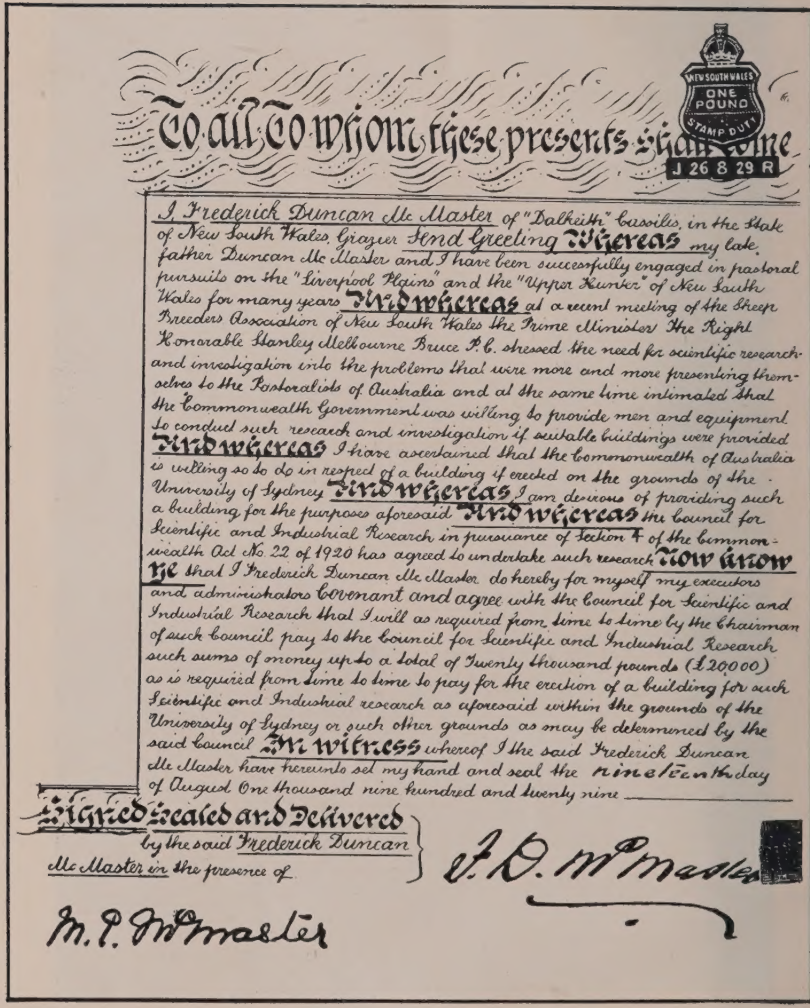
PLATE 1.

MR. F. D. MCMASTER.

Mr. F. D. McMaster of "Dalkeith," Cassilis, New South Wales, has recently made the Council a gift of £20,000 for the erection of a laboratory to specialize upon diseases of animals. (See page 193.)

[*To face p.* 242.

PLATE 2.



To all To whom these presents shall come

NEW SOUTH WALES ONE POUND STAMP DUTY J 26 8 29 R

I Frederick Duncan Mc Master of "Dalkeith" bassilis in the State of New South Wales Grazier Send Greeting Whereas my late father Duncan Mc Master and I have been successfully engaged in pastoral pursuits on the "Liverpool Plains" and the "Upper Hunter" of New South Wales for many years And whereas at a recent meeting of the Sheep Breeders Association of New South Wales the Prime Minister The Right Honorable Stanley Melbourne Bruce P.C. shewed the need for scientific research and investigation into the problems that were more and more presenting themselves to the Pastoralists of Australia and at the same time intimated that the Commonwealth Government was willing to provide men and equipment to conduct such research and investigation if suitable buildings were provided And whereas I have ascertained that the Commonwealth of Australia is willing so to do in respect of a building if erected on the grounds of the University of Sydney And whereas I am desirous of providing such a building for the purposes aforesaid And whereas the Council for Scientific and Industrial Research in pursuance of Section 4 of the Commonwealth Act No. 22 of 1920 has agreed to undertake such research Now know ye that I Frederick Duncan Mc Master do hereby for myself my executors and administrators Covenant and agree with the Council for Scientific and Industrial Research that I will as required from time to time by the Chairman of such Council pay to the Council for Scientific and Industrial Research such sums of money up to a total of Twenty thousand pounds (£20000) as is required from time to time to pay for the erection of a building for such Scientific and Industrial research as aforesaid within the grounds of the University of Sydney or such other grounds as may be determined by the said Council In witness whereof I the said Frederick Duncan Mc Master have hereunto set my hand and seal the nineteenth day of August One thousand nine hundred and twenty nine

Signed Sealed and Delivered by the said Frederick Duncan Mc Master in the presence of

F. D. McMaster

M. P. McMaster

The " Deed of Gift " prepared on behalf of Mr. F. D. McMaster to give effect to his gift of £20,000